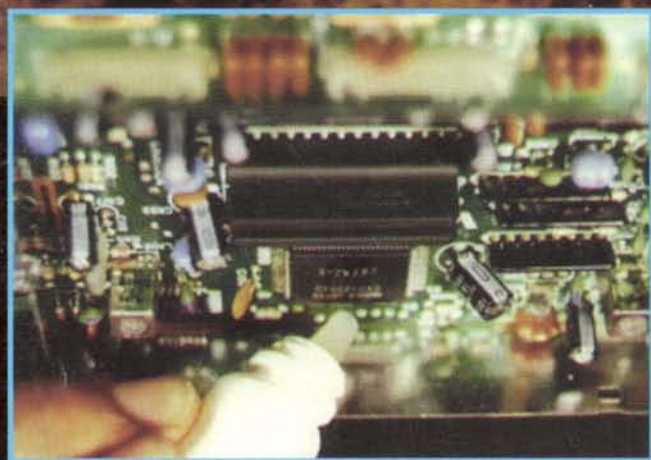


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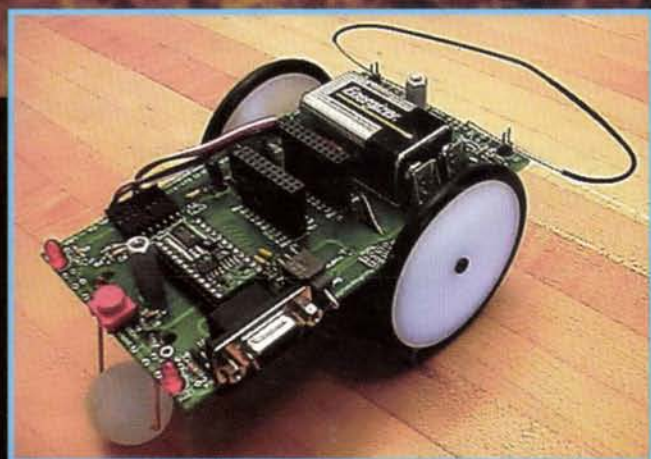
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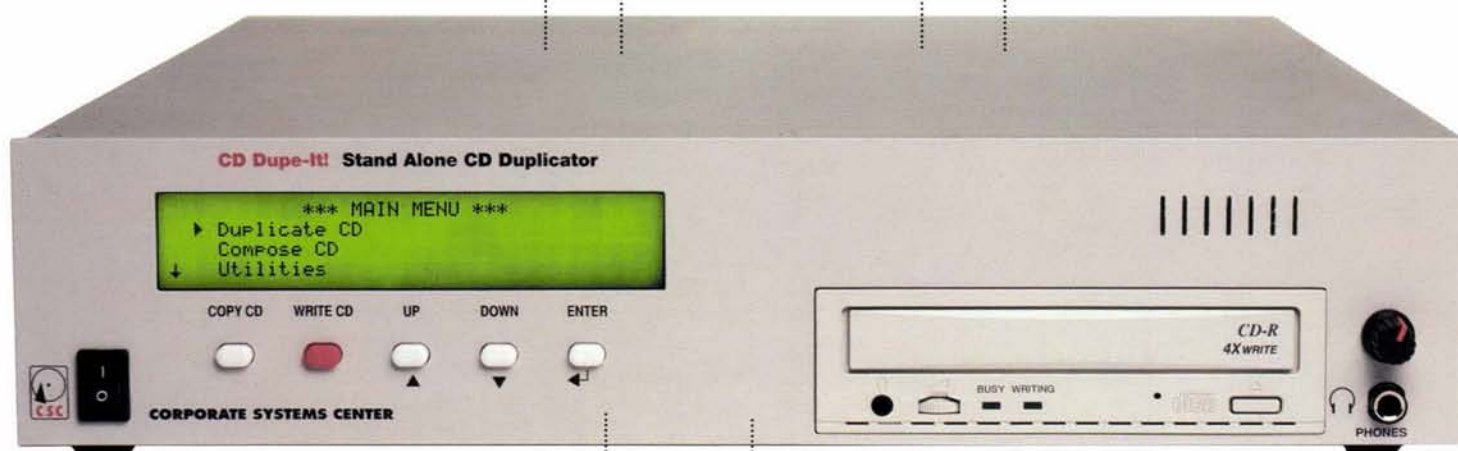


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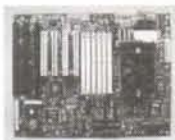
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- ◆ All we have is cameras with stand, and SCSI-II interface
- ◆ The camera is on a weighted stand that extends from 13" tall to over 20" tall, and has a stereo microphone
- ◆ Color camera is digital output only (not NTSC) as far as we can tell -- but who knows?
- ◆ Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video out (BNC), and the connector for the camera cable.
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Articles ...

SOME PRACTICAL LIGHT METERS — PART 2

Determine and construct the specific "lighting" system which suits your particular needs, and learn the details that apply to that system.

Evert Fruitman ... Page 6

SAFE AND SANE SMD REPAIR

Learn how to successfully remove and replace SMD chips.

TJ Byers ... Page 9

BUILD THE POT BOX

Useful to experimenters and circuit designers, this inexpensive decade potentiometer box allows you to conveniently determine the best value of resistance to use in a circuit.

Fred Blechman ... Page 19

THE "OPTO" IN OPTOELECTRONICS — PART 2

Learn the basic nature and behavior of optical prisms and lenses in this installment of a four-part series.

Ray Marston ... Page 31

BUILD A SEPIC REGULATOR FOR YOUR BATTERY-POWERED DIGITAL PROJECT

Portable power for your portable electronics is not a trivial consideration.

Fernando Garcia ... Page 66

MARINE ELECTRONICS FOR THE LAND RV MARKET

Electronics that go into boats and vehicles share a lot of common applications. Find out the advantages of technology exchanges between these two markets.

Gordon West ... Page 87

Columns ...

AMATEUR ROBOTICS NOTEBOOK

A GrowBot review, Breadbot code on-line, and SIMMStick Design Contest99 details.

Robert Nansel ... Page 89

ELECTRONICS Q & A

TJ Byers ... Page 74

OPEN CHANNEL

Some design rules for building circuits.

Joe Carr ... Page 14

RESOURCE BIN

Exploring used test equipment options.

Don Lancaster ... Page 83

STAMP APPLICATIONS

One step beyond the application note.

Lon Glazner ... Page 25

THE COMPUTER-CONTROLLED WORLD

Due to unforeseen circumstances, The Computer-Controlled World will be postponed for one more issue. We apologize for any inconvenience this may have caused.

Departments

Advertiser's Index ... 78
Classified Ad Info ... 78
Dealer Directory ... 30
Events Calendar ... 56
New Product News ... 93
News Bytes ... 35
NV AdMart ... 80-81
NV Bookstore ... 10
Prize Drawing ... 85
Reader Feedback ... 18
Tech Forum ... 37

Classified Ad Index

10. Ham Gear for Sale ... 39	90. Satellite Equipment ... 45	145. Robotics ... 49
20. Ham Gear Wanted ... 0	95. Military Surplus Electronics ... 0	150. Plans/Kits/Schematics ... 50
30. CB/Scanners ... 39	100. Audio/Video/Laser ... 46	155. Manuals/Schematics ... 51
40. Music & Accessories ... 40	110. Cable TV ... 46	Wanted ... 51
50. Computer Hardware ... 40	115. Telephone/Fax ... 48	160. Misc. Electronics For Sale ... 51
60. Computer Software ... 41	120. Components ... 48	170. Misc. Electronics Wanted ... 52
70. Computer Equip. Wanted ... 42	125. Microcontrollers ... 48	175. BBS & Online Services ... 0
80. Test Equipment ... 42	130. Antique Electronics ... 48	180. Education ... 0
85. Security ... 45	135. Aviation Electronics ... 49	190. Business Opportunities ... 52
	140. Publications ... 49	200. Repairs/Services ... 53

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Jack Lemieux N6ZTD

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Larry Lemieux KD6UWV

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Some Practical Light Meters — Part 2

by Evert Fruitman W7RXV

An old saying in photography goes no light, no picture.

Putting It Together

Last month, we went over several ideas regarding light meters in some detail. Now, as we start to construct the systems, we will go into

already soldered wires. Connect the wires to an ohmmeter, or connect a resistor from 1,000 ohms to 4,700 ohms, a battery, and a 0-1 milliamp meter in series. One side of the resistor

tion changes. Hooking the transistor up backwards in this circuit will not harm it.

You may use a CdS, light-dependent resistor for the photo cell instead of the photo transistor as I did in the final version of my

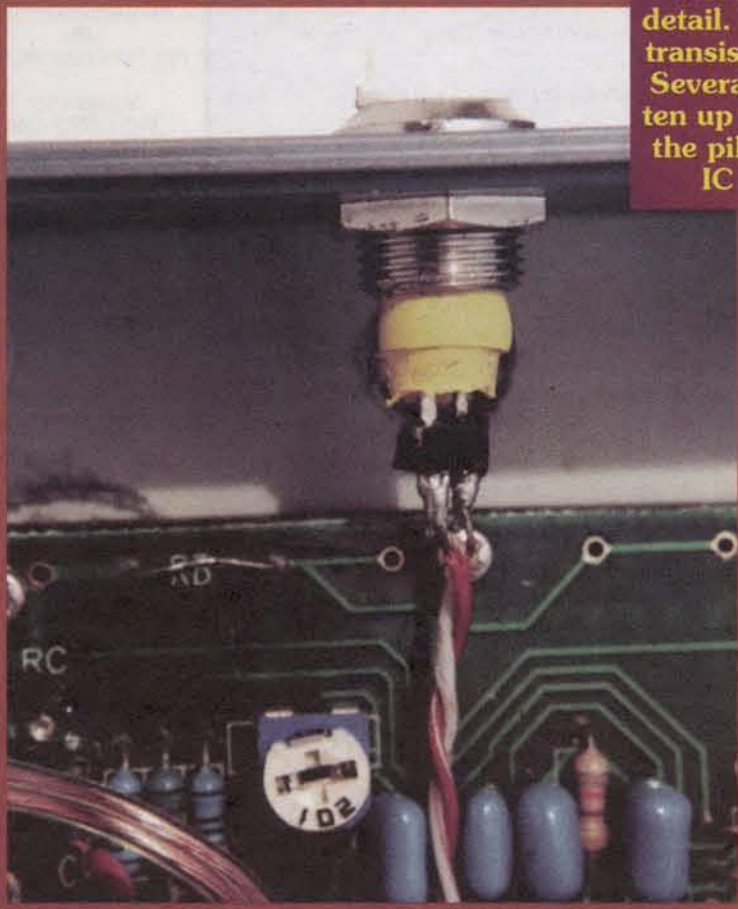


PHOTO A. Photo transistor mounting detail. In this case, digital display. Photo transistor will work with analog version. Several layers of heat shrink tubing fatten up the transistor enough to hold it in the pilot light holder. Two pins from an IC socket make the connections.

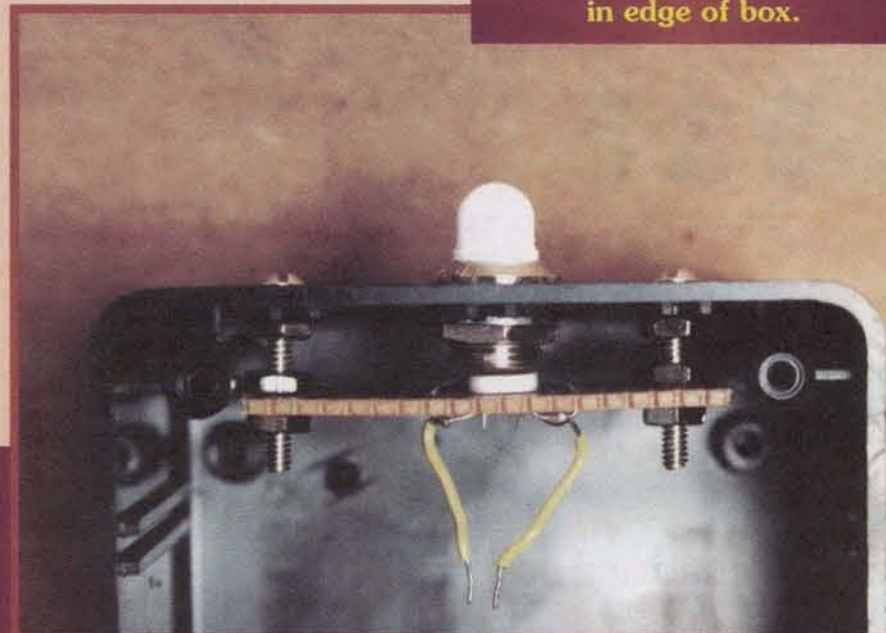


PHOTO B. Detail of CdS photo cell mounting. CdS cell mounted on perfboard. Board secured to box with small machine screws. Pilot light holder, used as diffuser, mounted in hole in edge of box.

specific details that apply to a particular system. We will start with the simpler, ambient light meter of Figure 1.

Simple Analog Meter for Ambient Light

This is about the simplest stand-alone unit you could make. It consists of three resistors, a photo cell, a regulator, a meter, a couple of switches, the battery, and the box. You could put the parts on a piece of perf board. The capacitors connect to the regulator just as shown in the diagram. Put an ON/OFF switch between the battery plus (+) and the input to the regulator.

You will have to determine which side of the photo transistor goes to plus and which side goes to the meter. Usually they mark the leads. You can verify that with an ohmmeter; either analog or digital. A DMM will show a marked change in resistance as you move the photo transistor into brighter light. The meter on an analog ohmmeter will tend to 'follow' the light changes if you have the leads correctly connected. Use an intermediate range, RX100 to RX1000 on an analog meter. Select something around 2,000 to 20,000 on a digital meter.

If you use the plug-socket arrangement shown in Photo A, you can determine the correct connections in a more convenient way. Plug the transistor into the socket, to which you have

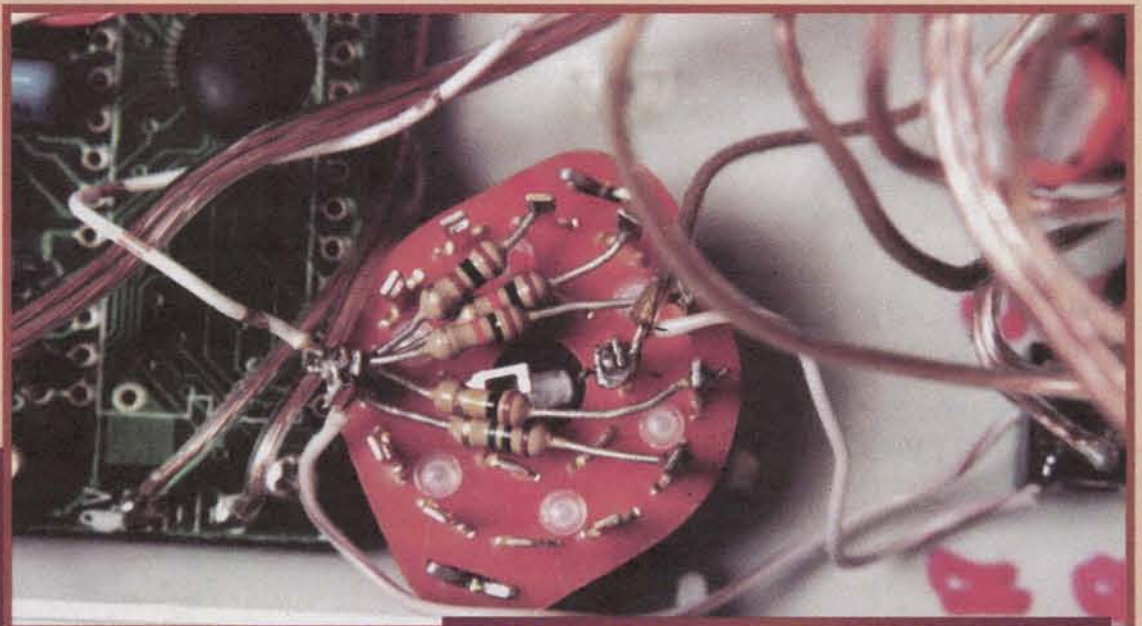


PHOTO C. Range switch detail, prototype version. Range resistors mount directly on switch to reduce the number of wires going to the board.

goes to one side of the transistor, the other side of the transistor goes to the battery, etc.

If the meter does not seem to follow the light changes, reverse the connections to the transistor and try it again. When you have the correct connections, it will definitely follow the light level changes. The socket allows convenient connec-

analog meter. The CdS cell does not care which lead connects to the battery plus. A socket still makes a handy way to connect to the photo cell. Photo B shows the mounting details for the CdS cell.

The socket consists of two pins cut off of a machine-pin IC socket. The red wire in Photo A indicates the collector lead. While that photo shows the photo transistor in the digital version, the photo transistor will work with either system. We will get to calibration later.

Simple Digital Meter for Ambient Light

Figure 2 gives the circuit of the light meter which is a step up in complexity. It uses a few more parts, but as explained earlier, it gives us a more sensitive instrument. Instead of a two-position range switch, it uses a six-position switch, although you could limit it to just two ranges and use the smaller, simpler switch.

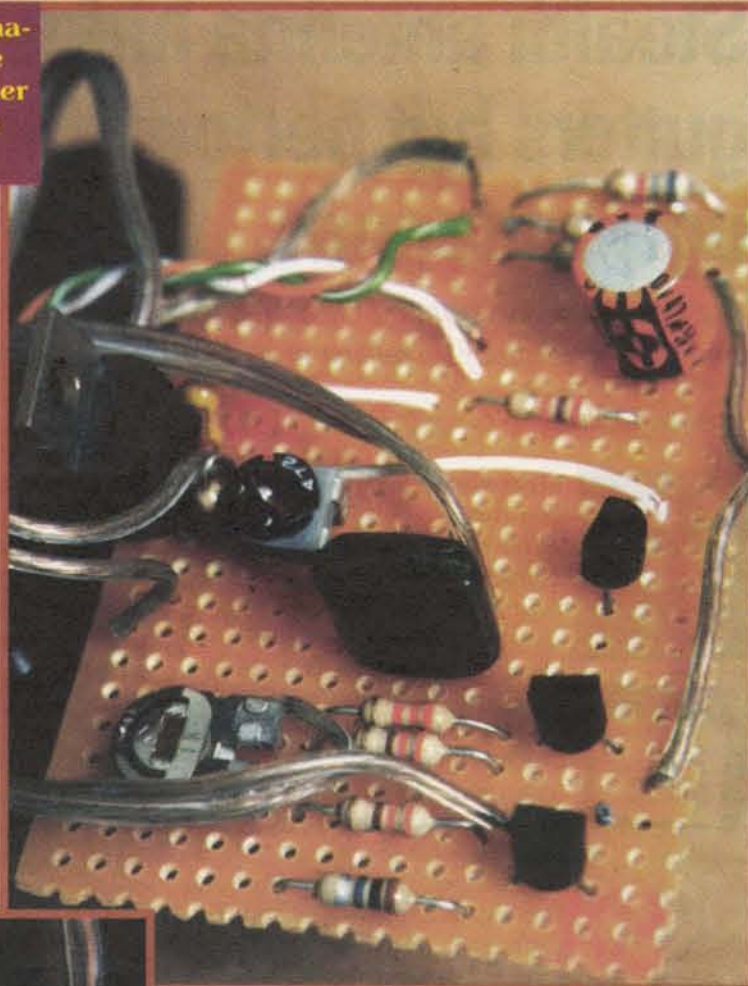
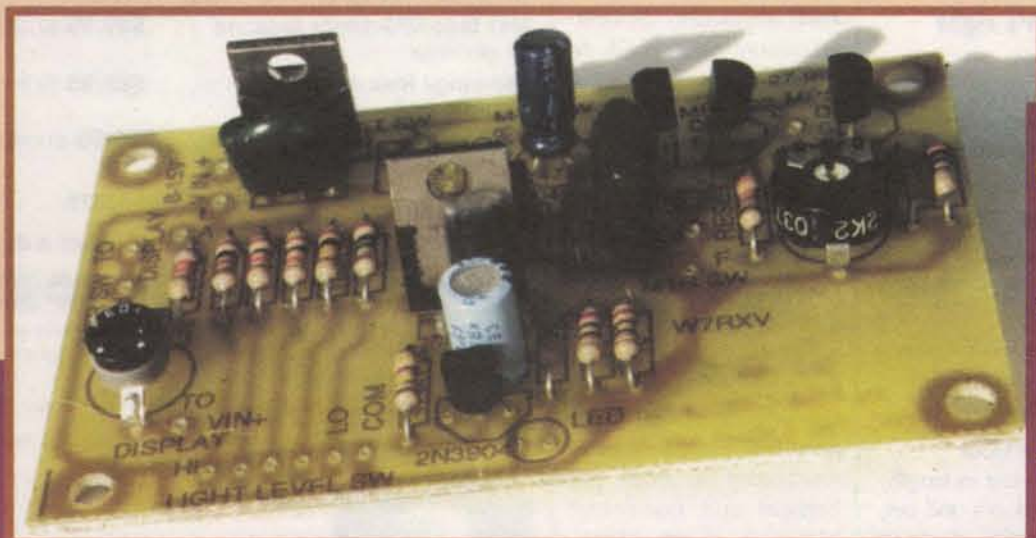
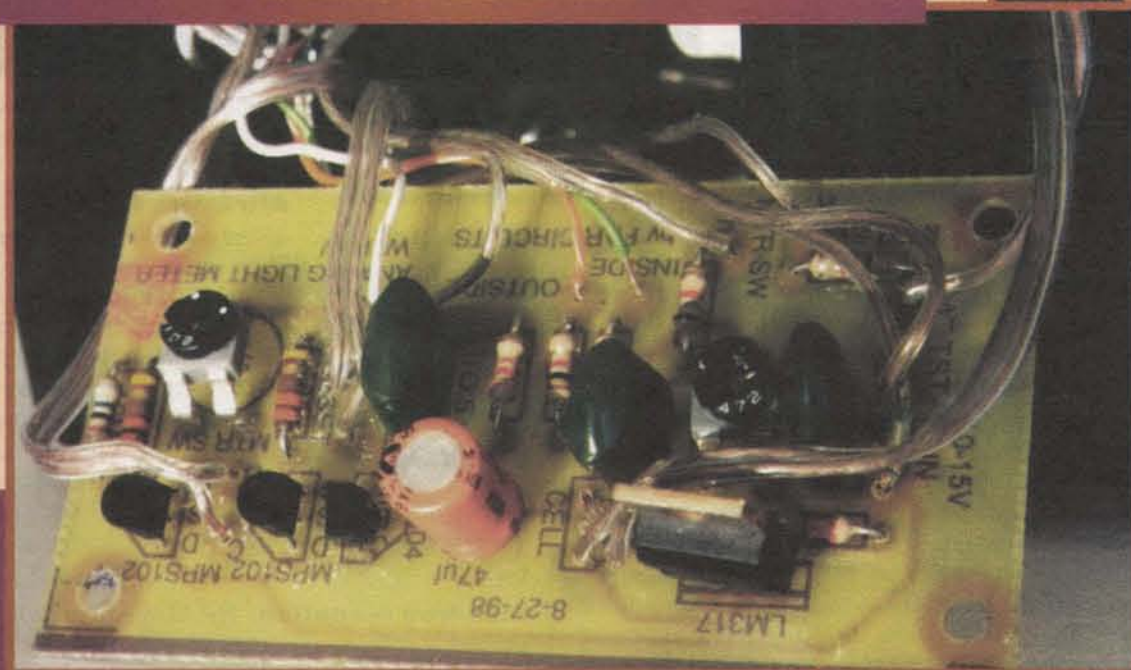
The digital panel meter, possibly cheaper than its analog counterpart, needs a separate battery for its power. It also needs the voltage divider on the input to limit the voltage. The meter battery gives long life and, up to the point where the readout becomes too dim to read, the battery voltage does not seem to affect accuracy.

PHOTO D. Prototype version of analog board. Regulator and voltage adjust control, center left. Voltmeter balance control, lower left. FETs lower right. Diode, center right.

The voltage divider helps match the expected range of input voltages to the allowable range of input voltages. Most of these meters will have a basic sensitivity of 200 mV. They will read 199 or 199.9 mV. At 200 mV input or more, they show a 1 followed by a blank scale. Within reasonable limits, you may exceed the nominal 200 mV input without damaging the meter. I picked values that would keep the input voltage within that limit on some setting of the range switch, and with the light levels that it should see.

In the prototype version, for

PHOTO E. Analog board. Adjustable regulator, lower right, allows almost full use of 12 volts' worth of penlight batteries. Voltage adjust control, upper right, just in back of regulator. Balance pot upper left. FET voltmeter, lower left, right next to transistor used as diode.



ease of mounting and to minimize the number of wires running around the box, I put the range resistors directly on the switch as shown in Photo C. From top to bottom, you have the resistors for the Highest light level to the Lowest. Note that we use only five resistors for six ranges. The two most sensitive ranges show only about a 10% difference in sensitivity. However, the last range costs nothing extra, so we may as well use it.

If you put the range resistors on the back of the RANGE switch, you will still need a piece of perf board for the 82 K resistor and the 10 K sensitivity control. When you get those wired, turn the sensitivity control to about the middle of its range. You will make the final adjustment later.

Wiring the Digital Panel Meter

The other parts in Figure 2 could go on a piece of perf board. Put an ON/OFF switch between the battery plus and the input to the regulator. Remember, the digital version needs a separate battery for the digital panel meter.

That means that the ON/OFF switch will have to have two poles: four contacts. With its greater sensitivity, the digital version uses a five-volt regulator and just a nine-volt battery. The adjustable regulator needs more parts around it in order to set the desired voltage. The five-volt regulator needs no adjustment; 7-30 volts in, 5 volts out, simpler wiring.

Packaging It

Select a box large enough to hold the DPM and, most likely, it

PHOTO F. Digital board. Ready to go into box. Five-volt regulator, upper left. Meter range-trim control, lower left. Auto-reset transistor, center. FET voltmeter, upper right. Voltmeter, balance control, center right.

Continued on Page 58

Stealth antenna hides under gutters but performs like big ugly antennas

The new Max Antenna by GE is the low-profile, high-gain way to get flawless reception of broadcast signals without expensive installation.

by Hope Chapman



The Max Antenna by GE is the ultimate TV antenna system.

Electronic engineers agree—you're television is only as good as the signal it receives. Unfortunately, antenna design has not kept pace with improvements in television quality and the features available. Both cable and satellite television systems have spent a great deal to improve the quality of their transmission, but they can be extremely expensive, they aren't available in all areas and may not provide access to local TV stations. The advent of digital broadcast television is about to change the face of television, and in the near future, broadcasters will begin transmission of these high definition signals. This will

mean that you won't need to pay outrageous cable bills or subscribe to satellite programming to get the perfect picture.

So people have headed back up to the attic and pulled their old rabbit ears out of storage. What they'll find is that although rabbit ears will provide reception of over-the-air signals, they are just as ugly and just as difficult to adjust as ever. Luckily, there is a new antenna from GE that will provide breakthrough performance without making your family room look like something out of the fifties.

Fuzzy outlook. If you subscribe to cable, you receive a quality picture on most channels, as long as storms or other factors don't disrupt your service. Unfortunately, the interference caused by the signal bouncing off buildings and other large objects, known as multipathing, often results in "ghosting" or "snow." If you'd rather

not pay a hefty monthly sum for the privilege of receiving a signal, your options have been limited, and your picture was likely to be distorted. You could always mount a huge antenna on your roof, but that's not even allowed in some neighborhoods. Then there's the problem of aiming the antenna at the broadcast source.

Clear alternative. The Max Antenna series from GE uses a revolutionary electromagnetic design to maximize installation flexibility and yield longer range reception of off-air VHF and UHF signals. Unlike a conventional dipole antenna, the Max Antenna can receive signals in both vertical and horizontal planes with minimum cross-polarization loss. This design allows for the first low-profile antenna solution that provides numerous installation options.

Superior components. The key to the superiority of this antenna is its ingenious use of the latest electromagnetic technology—providing high gain and full channel coverage as well as the greatest amount of mounting flexibility. First, the antennas were designed

around a wide band element to achieve the greatest amount of gain in a relatively small space. Next, an amplifier and matching network was designed to enhance the reception of weak signals. This amplifier also adds very little distortion to the strong signals, giving it a balanced amount of gain. A filter on the amplifier board will allow for good matching

between the antenna and amplifier. Special attention was paid to design an antenna-amplifier combination that would be completely compatible with the new digital transmission format. It has been designed for strong signal distortion rejection and a low amount of noise. The scientists who designed it followed certain optical principles to give the antennas good sensitivity in both the vertical and horizontal plane. It is omnidirectional and requires no adjustments, orienting



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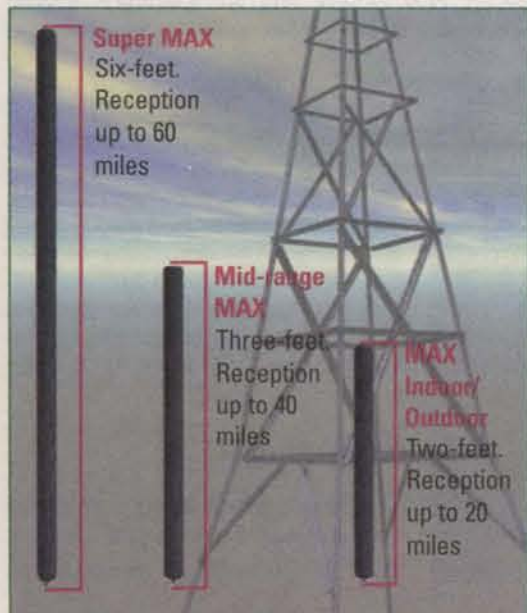
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Safe and Sane SMD Repair

How To Successfully Remove And Replace SMD Chips

For more years than I care to admit, I've troubleshooted and repaired all sorts of electronic devices, everything from appliances to car stereos to TVs to satellite equipment. Over the years, I've seen many changes — most of which require stronger eyeglasses as the size of the parts shrink. (Don't know about you, but spotting an eagle at 300 yards is easier than spotting a bad 10 mil solder joint.) This progress has also changed the way defective parts are replaced. The latest challenge is SMD — surface mount devices.

Unlike traditional DIP (dual in-line plastic) components — which are a

all sorts of materials. Let's take lead, one of the earliest discoveries, for instance. As a kid, I remember the stench of burning calking rope as my father ladled molten lead (like gravy at Thanksgiving) into the joints of a soon-to-be sewer pipe. It quickly solidified and made a water-tight seal (well, after a bit of pounding). My dad also used lead, in the form of solder, to weld copper water pipes and other plumbing fixtures.

In fact, the word plumber comes from the Latin word *plumbum*, which means lead (Pb in chemistry). Back in Roman times, lead — a very malleable, non-corrosive metal — pounded into the shape of pipes was used for both fresh water delivery and

There are many kinds of solder, all of which use tin as a base. To this is added various amounts of lead, silver, or other elements to characterize the melting point and strength of the bond. Table 1 shows the most popular blends.

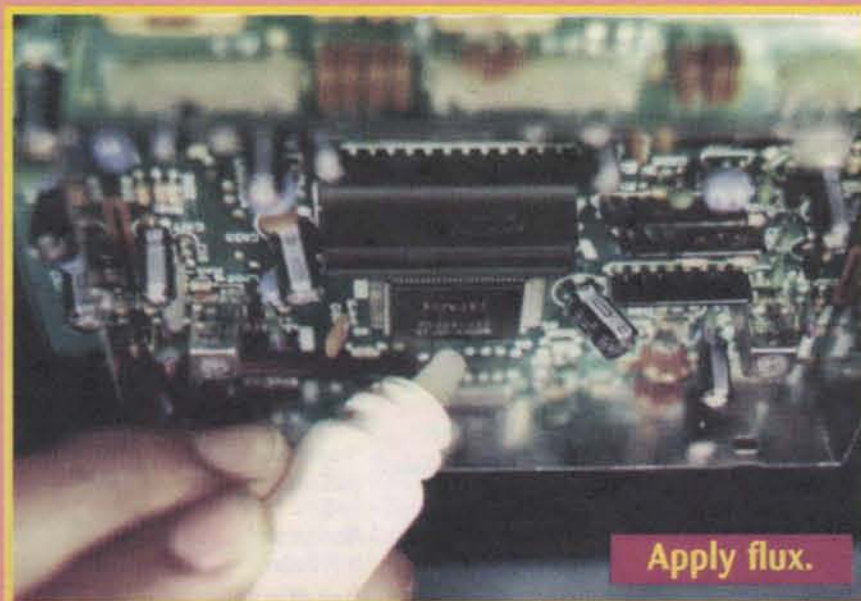
Generally, the higher the melting temperature, the stronger the bond. Unfortunately, semiconductors are very sensitive to sustained high temperatures. As the temperature rises, so does the risk of failure.

Making An SMD Board

When an SMD board is manufactured, the surface mount chip is "glued" in place on the board using a

is placed in an oven, and the temperature raised until the solder melts. The temperature is then reduced and the board removed. Timing here is critical because you need enough heat to melt the solder, but not so much that'll damage the IC. Here's a brief overview of how each works (Figure 1).

Vapor-phase reflow soldering is currently the most popular and consistent method. It uses a liquid fluorinated compound for the heat-transfer medium. The board is inserted into a sealed chamber and the liquid is heated to its boiling point, at which point it turns into "steam." The temperature of the vapor is determined by the fluid type (Table 2). Dwell time in the



Apply flux.

challenge in themselves with plate-through solder pads — SMD parts have tiny, fragile leads that attach to tiny printed circuit board pads that are even more fragile than the leads themselves. Too much heat, and ... poof, the pad and its link to other pads/traces are history.

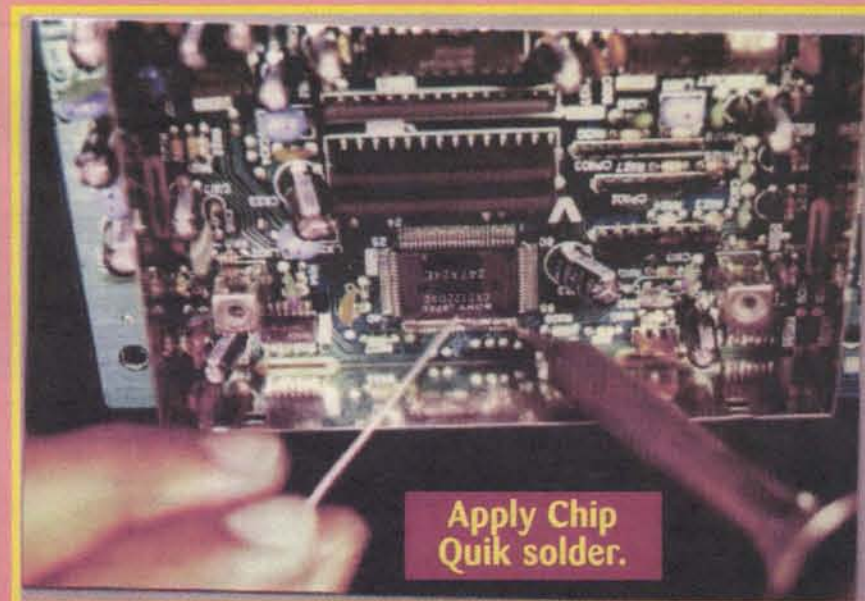
The mission, should you wish to accept it: How do you remove a defective SMD part from a multi-layer PC board and have the copper pads/traces survive? Simply lower the heat, the experts tell us.

It's All About Solder

Somewhere around the Bronze Age (3500BC), man learned how to extract and alloy metals to forge weapons, cast sculptures, and bond

waste disposal. Today, we know the deadly consequences of heavy-metal poisoning, and lead pipes have long given way to steel, copper, and plastics.

However, lead-based compounds are still used extensively in the electronics industry. For example, I use lead-solder every day to connect components to each other and tack them onto circuit boards. If you've ever tried it, though, you have discovered it takes a lot of patience and skill. The hardest part of getting a perfect solder joint is temperature control. Too little heat produces a solder joint that's grainy and brittle; too much heat, and you run the risk of destroying the parts you're trying to bond. How much heat you need depends on the type of solder.



Apply Chip Quik solder.

solder paste. The board is then heated to the point where the solder melts and "reflows," that is, it becomes liquid and fills the voids between the lead and the circuit board pad. However, the reflow temperature is typically 419 °F (215 °C), well above the glass-transition temperature of epoxy (320 °F, 160 °C), where the material undergoes a transition from a solid to a plastic state. Fortunately, it takes longer for the epoxy case to melt than it does for the solder to reflow, so no damage is done if the heat isn't applied for too long — typically 15 seconds.

The two widely-used SMD soldering methods are infrared reflow and vapor-phase reflow. Both melt and reflow the solder through total board immersion. That is, the board

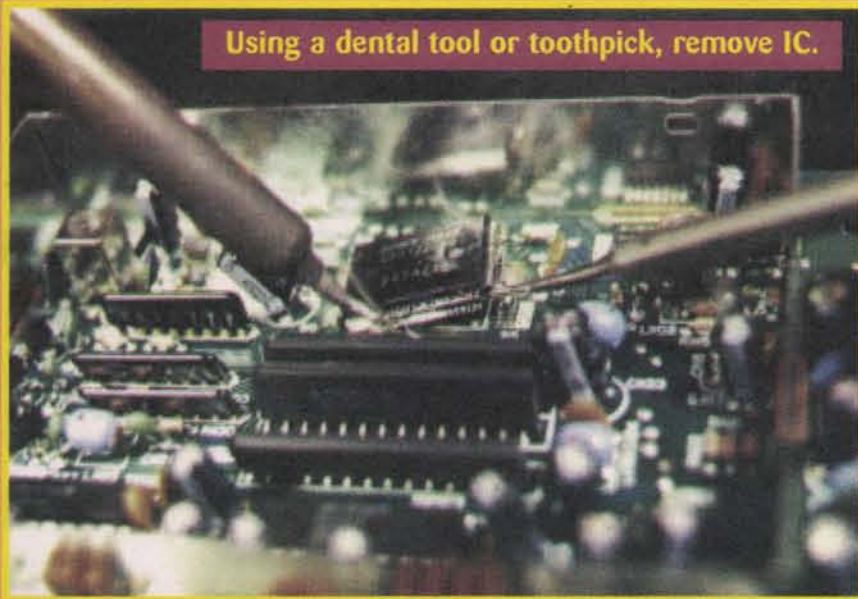
chamber is generally on the order of 15-30 seconds, depending on the mass and density of the board.

Infrared reflow uses air for the transfer medium, and is actually a mixture of infrared heating and convection oven technologies. The heating is generated by infrared lamps or panels, and the air circulated with a blower to prevent stratification. Because the medium is dry air rather than moist vapor, it takes longer to heat the board to reflow temperature. On the other hand, the method produces less thermal stress on the board.

Repairing SMD Boards

When replacing a defective SMD component, the hobbyist doesn't

Using a dental tool or toothpick, remove IC.



have the precise temperature control used to initially place the part. Obviously, the worry isn't the dead IC, but the traces on the PC board. If you apply too much heat, the adhesive that bonds the copper trace to the board will "melt" and let go. What you're left with is a dangling pad, or worse, no pad at all (you'll likely find it stuck to the tip of the soldering iron).

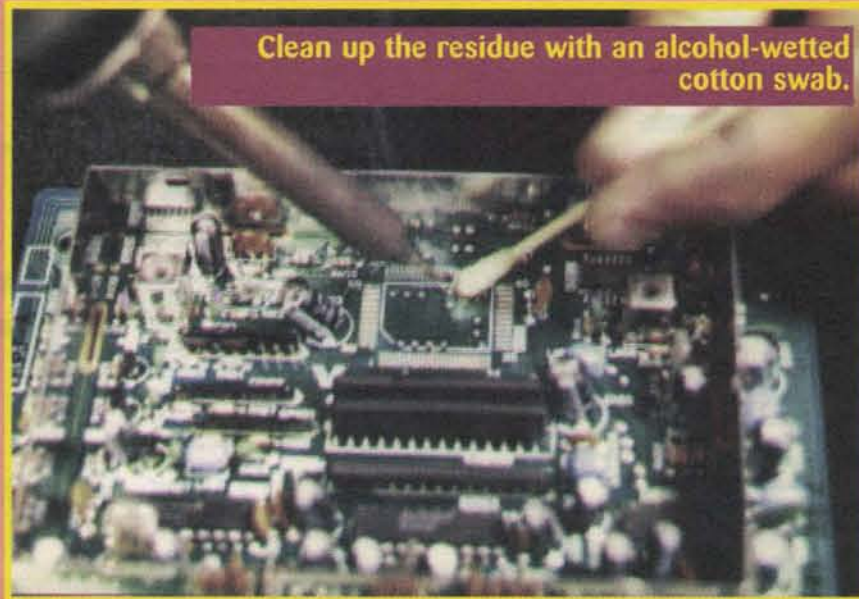
Until recently, the only SMD removal process economical enough for the hobbyist was done using flux-saturated braid, like the No-clean SMD Repair Kit from Kester, which is available from Jameco (1-800-831-4242; <http://www.jameco.com>), Mouser Electronics (1-800-346-6873;

<http://www.mouser.com>), and other supply houses.

The idea is to remove as much solder as possible, at least enough to weaken the solder bond, using the braid as a solder wick. Then a light touch of the soldering iron tip would, hopefully, pop the lead loose. This is no easy chore when a chip has the footprint of a centipede. Moreover, wedging the braid and hot iron tip into the limited space between SMD parts without breaking something is a formidable task.

The alternative is to clip out the IC with a pair of diagonal cutters, leaving the leads sprouting from the PC board like grass. One by one, the leads are removed using a soldering

Clean up the residue with an alcohol-wetted cotton swab.



iron and tweezers. In fact, it's the only way I've been able to successfully remove LSI (large scale integration) ICs using the Kester Repair Kit. Unfortunately, this method often damages delicate solder pads before heat is applied.

Removing SMDs The Safe Way

The new, smart way to remove SMDs is with a special solder made by **Chip Quik** (1-800-836-2447; <http://www.chipquikinc.com>). The solder is an alloy of tin, lead, indium, and bismuth. Bismuth is a heavy metal that's one step above lead on the periodic table, and is the most

diamagnetic of all metals with a thermal conductivity lower than any other metal, except mercury.

When tin and bismuth are "amalgamated," it reduces the melting point of the solder to a very low 136 °F, as opposed to the 361 °F melting point of 60/40 solder. When you melt the new solder with the old — the resultant alloy has a melting point of about 150 °F (well below the boiling point of water). At temperatures this low, it's nearly impossible to damage the solder pads.

The procedure is easy and painless. It involves four easy steps, which are outlined in Photos A through D. The process starts by applying a drop

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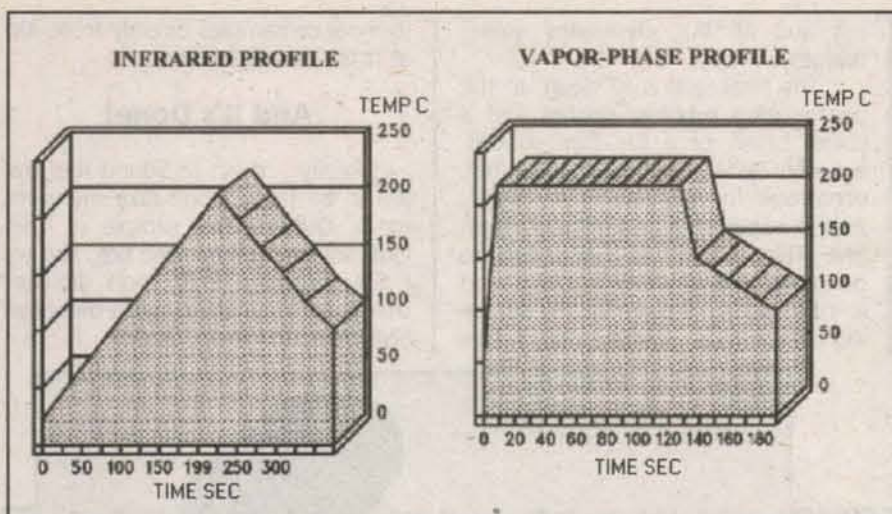


FIGURE 1 — Temperature control is important. The two leading and safest SMD reflow soldering methods are infrared and vapor-phase.

of flux from the included syringe to each lead of the part to be removed (Photo A).

Next, melt a dab of Chip Quik solder on each to the leads using a small (30W) soldering iron — just pretend like you're soldering the chip in place rather than removing it. Be liberal with the Chip Quik solder (Photo B), and don't worry about solder bridges (slipovers).

Once the leads are treated, apply heat to the leads until the new solder is molten, and lift the SMD off the board using a dental tool (Photo C) or vacuum pick.

After the part is removed, you'll notice an unsightly mess left behind. This is solder "ash," a result of the interaction between the ChipQuik solder and the old solder, which has to be removed to expose the pad underneath. Clean-up is done with a

Sources Mentioned

3M
http://www.3m.com

Chip Quik
25 Nicholas Rd.
Framingham, MA 01701
1-800-836-2447
http://www.chipquikinc.com

Digi-Key Corp.
701 Brooks Ave. South
Thief Falls, MN 56701
1-800-344-4539
http://www.digikey.com

Howard Electronic Instruments
6222 N. Oliver
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1-800-394-1984
http://www.heinc.com

Jameco
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Belmont, CA 94002
1-800-831-4242
http://www.jameco.com

Mouser Electronics, Inc.
2401 Hwy. 287 North
Mansfield, TX 76063
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http://www.mouser.com

cotton swab dipped in flux (Photo D), followed by an alcohol wipe. The Chip Quik SMD-1 SMD Removal Kit contains enough solder to remove 8-10 44-pin SOIC packages.

SMD Replacement

What's left is a clean footprint, ready to accept the new SMD. The

new part can be soldered in place using any number of techniques. My favorite is wetted solder paste, like the R244 formula from Kester (available from Digi-Key, 1-800-344-4539; http://www.digikey.com). This paste is a blend of 90 percent solder and 10 percent gooey flux that is applied in a bead along the newly-cleaned pads using a syringe.

With a pair of tweezers and magnifier, carefully align the new SMD in place so that it lands squarely on the pads. Let it set for a few hours to harden the paste. Use a low-wattage iron — about 15 watts — with the smallest chisel-tip you can buy (RadioShack 64-2055, or equivalent) to solder the

TABLE 1 — PHYSICAL PROPERTIES OF ELECTRICAL SOLDER

RadioShack	% Tin (Sn)	% Lead (Pb)	% Silver (Ag)	Melting Point (°F)	Bond Strength
—	98	—	—	450	Very high
—	—	98	—	608	Low
64-001	60	40	—	361	Medium
64-015	63	37	—	361	Medium
64-013	62	36	2	354	High
64-025	95	—	4	421	Very high
64-027	97	—	3% Cu	410	Medium
Chip Quik	48	28	21% In, 3% Bi	136	Very low

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TABLE 2
POPULAR VAPOR-PHASE SOLVENTS

Solvent	Boiling Temperature
FC-70	419 °F 215 °C
FC-71	487 °F 253 °C
FC-5312	419 °F 215 °C

chip in place. Begin by tacking down two or three of the corner leads. This prevents the chip from shifting while you heat the remaining leads.

A trick of the trade is to heat the bottom side of the circuit board to about 150 °F with a hair dryer or hot

air gun before soldering the chip. This reduces the amount of time it takes for the solder to reflow when touched by the soldering iron, thereby lowering the heat transferred to the IC and reducing the risk of damage.

Another trick is to drag the solder tip parallel to the body of the IC (perpendicular to the leads) at a rate just slow enough to melt the solder along the way.

Never touch the pads or the pins; let the ball of solder carry the load of the work for you. Combining these two techniques minimizes chip heat-

ing and all but eliminates solder bridges.

The final step is to clean up the board using rubbing alcohol and a solder brush or a CFC-free solvent, like HFE-71DA — a hydrofluoroether, azeotrope formulation with trans-1, 2-dichloroethylene and ethanol, from 3M. This mixture is well-suited to defluxing and degreasing tasks, and is intended to replace ozone-depleting compounds. You can obtain free

four-ounce samples directly from 3M at <http://www.3m.com>.

And It's Done!

Really — that's it. Sound too simple to be true? Don't take my word for it. Order a free sample of Chip Quik solder via their web site, and try it for yourself. You'll soon discover that there's still life in those defective SMD toys and tools. **NV**

Inexpensive SMD Repair Kit

Howard Electronic Instruments has put together a very inexpensive package for removing and replacing SMD components at a very low temperature. The package contains an EDSYN 951SX temperature-controlled soldering station outfitted with a Mini-Wave Soldasip tip, and contains a Chip Quik SMD-1 SMD Removal Kit.

The EDSYN 951SX soldering station has a wattage rating of 15W to 220W, very delicate to heavy-duty soldering, with an adjustable tip temperature of 400 °F to 800 °F, ±5 °F. The patented Mini-Wave Soldasip solder tip, also from EDSYN, is a cylindrical tip cut at a 45-degree angle on the end. The tip end is cupped, or convex, so that it will hold solder in the cup.

To install a SMD part, flux is applied to the leads of the IC and the Mini-Wave cup filled with regular wire solder. Holding the iron at a 45-degree angle, simply drag the solder tip parallel to the body of the IC (perpendicular to the leads).

As you move down the line, solder is applied to the leads, making a permanent bond between the IC's leads and the PC board's pads.

The price of the package is \$99.00, and comes with a 15-day free trial (30 days if you prepay). **Howard Electronic Instruments (1-800-394-1984; <http://www.heinc.com>)** is located at 6222 N. Oliver, Kechi, KS 67067.



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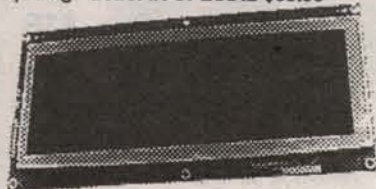
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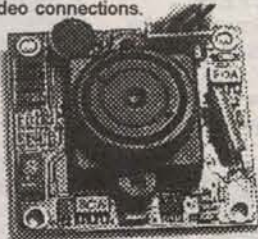
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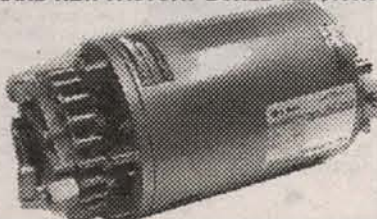
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Some Design Rules

by Joseph J. Carr

One of the facts of life that affects many people in amateur science and electronics is the fact that they must (or prefer to) build some of their own circuits (unless they are rich, or lucky in the surplus market). Even in schools and colleges, budgets are rarely so generous as to permit unlimited instrument buying. Some homebrewing, adaptation, improvising, and out and out chicanery is sometimes needed.

If you peruse the adverts in *Nuts & Volts* like I do every month, then you will note a large variety of high quality pieces and parts, along with complete instruments, offered for sale at good prices. With a war chest full of these items, a little ingenuity, and a bit of thinking, there is little reason why you couldn't cobble together something that works.

Sometimes, ingenuity asserts itself in funny ways. For example,

some years ago television tuners became voltage controlled. It was one way to cope with problems that TV designers faced, and allowed them to make a phase-locked loop (PLL) controlled receiver. A guy named Murray Barlowe in Bethpage, NY saw that tuner not in terms of TV, but as the basis for a spectrum analyzer. We will be discussing Murray's "Poor Man's Spectrum Analyzer" in these pages in the near future. In the meantime, if you want a pre-look, use your web browser to find "Science Workshop" in Bethpage, NY ... and visit Murray's web site.

The process of designing electronic instrumentation circuits or projects is a logical step-by-step process that can be learned. Like any skill, design skill is improved with practice, so one is cautioned against both excessive expectations "first time at bat" and discouragement if the

process did not exactly work out as planned the first time.

Some of the material in this column may be called "philosophy," and that may be a fair label to attach. Although many technical people claim to disdain "philosophy," we all have it and use it. It's just that some people think about it a lot, others think about it either a little or at only a few times, while others don't think about it at all — they take actions based not on a logically considered viewpoint, but rather, by dumb luck and pure default.

A Design Procedure

The procedure that one adopts to designing may well be different from what is presented below, and that's alright. The purpose of offering a procedure is to systematize the process. While it is conceivable that one can successfully design a circuit or instrument by a process similar to Brownian motion (Figure 1), it is the systematic approach (Figure 2) that most often yields success. This procedure assumes a product that is a one-of-a-kind instrument, as in a scientific laboratory or plant. Designing a product for production and sale follows a similar procedure, but involves marketing and production problems as well. The steps in the procedure — some of which are iterative with respect to each other — are offered below:

1. Define and tentatively solve the problem. Create multiple tentative solutions wherever feasible. In systems engineering this is called "eliciting requirements."
2. Determine the critical attributes required of the final product; incorporate these into a specification and a test plan that determines objective criteria for acceptance or rejection.
3. Determine the critical parameters and requirements.
4. Attempt a "block diagram" solution.
5. Apportion requirements (e.g., gain, frequency response, etc.)

to the various blocks.

6. If appropriate, make a first-cut guess at which functions ought to be in software and which in hardware.

7. Perform analysis and do simulations on the block diagram to test validity of the approach. If you are designing an electronic circuit, then software such as Electronic Workbench is useful. The manufacturer of this software has a website at <http://www.electronicworkbench.com>, or can be reached via ewb@interactive.com, or by phone at 1-800-263-5552.

8. Design specific circuits to fill in the blocks.

9. Build and test the circuits, and write the software.

10. Combine the circuits with each other on a breadboard ("integrate" the elements).

11. Test the breadboarded circuit according to a fixed test plan.

12. Build "brassboard" that incorporates all changes made in the previous steps. A brassboard is a full-up working model. For one-off amateur models, it may actually be the final article. In either event, it should be built the way you want the end product to look like.

13. Test brassboard and correct problems.

14. Integrate software and hardware.

15. Design and construct final configuration.

16. Test final configuration.

17. Put the product into service and enjoy it!

Solving the (Right) Problem

The purpose of the designer is to solve some problem or another using analog circuits, digital circuits, a computer, or whatever else is available in the armamentarium. There are two related problems often seen in the efforts of novices.

First, it is often the case that the designer will have a tentative favorite approach in mind before the problem is properly understood. Decisions are made based on what the designer is most comfortable doing. For example, many younger designers are likely to select the digital solution in a knee-jerk manner that excludes any consideration of the analog solution. Both should be evaluated, and the one that best fits the need selected.

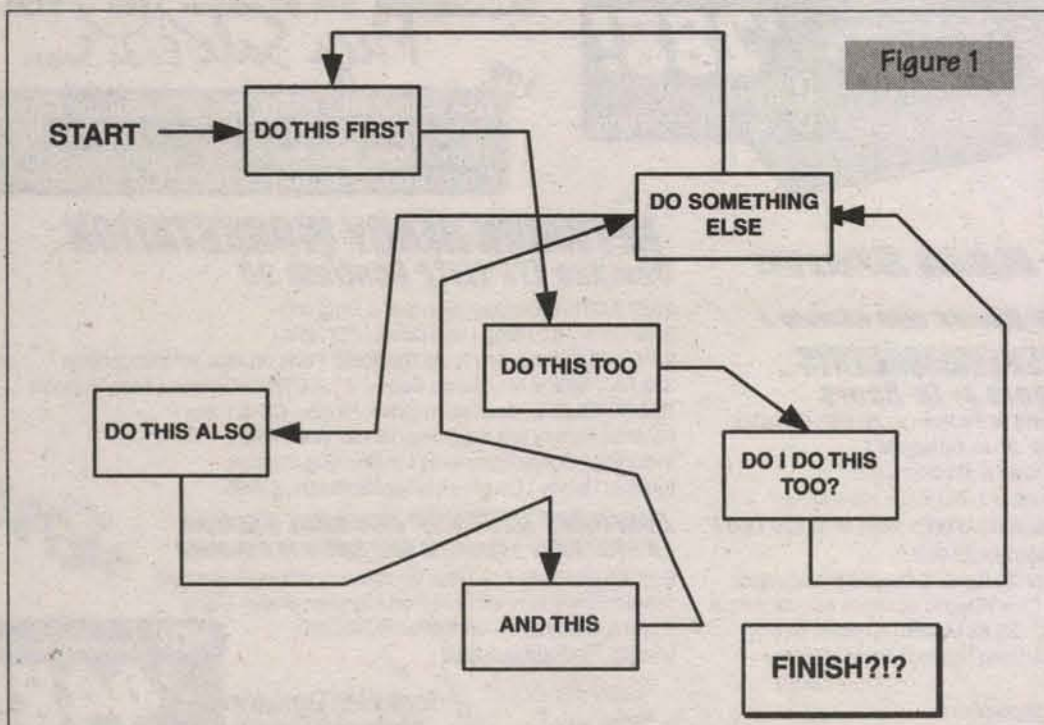


Figure 1

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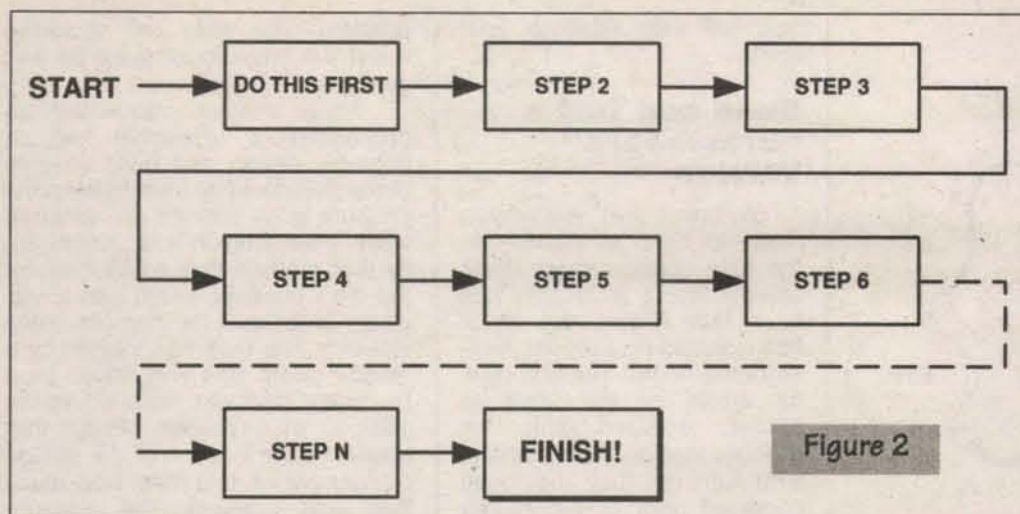


Figure 2

Second, be sure you understand the problem being solved. While this advice seems trivial, it is also true that failure to understand the problem at hand often sinks designs before they have a chance to manifest themselves. There are several facets to this problem. For example, a natural tendency of techies is to think that an elegant solution is complex and large-scale. If this mistake is made, then it is likely that the product will be over designed and have too many whistles and bells. It was, after all, designed to solve a much harder problem than was actually presented.

Another aspect to understanding the problem is to understand the final end use for the thing being designed. It is all too easy to get caught up in the specification, or our own ideas about the job, and overlook altogether what needs to be accomplished with the product.

An example is derived from the years I worked in the field of biomedical instrumentation. A physiologist requested a pressure amplifier that would measure blood pressures over a range of 0 to 300 mmHg (Torr). What the salesman never told the plant was a) it would be used on humans (safety and regulatory issues); b) that blood would come in contact with the diaphragm (cleaning and/or liquid isolation issues); and c) that it would occasionally be used for measuring 1 to 5 mmHg central venous pressures (which implies severe low-end linearity issues). The product that was delivered could not be used on anything living, human or animal.

Part of the problem in determining the level of complexity, or the specific design's function, is miscommunication between the end user and the designer. That makes for a funny conversation when these two "stakeholders" are the same person! Although miscommunications occur frequently between in-house designers and their "clients," it is probably most common between distant customers and engineers in the plant. Of course, marketing people may never let the engineer and customer get together (either from ignorance or a fear that the salesman's little lies will surface: "The reason I hate engineers is that, under duress, they usually blurt out the truth").

The proper role of the designer is to scope out the problem at hand, understand what the circuit or instru-

ment is supposed to do, how and where the user is going to use it, and exactly what the user wants and expects from the product.

Determine Critical Attributes

This step is basically the fruit of understanding and solving the correct problem. From the solution of the problem one can determine, and write down, a set of attributes, characteristics, parameters, and other indices of the product's final nature.

It is at this point that one must jot down a specification that documents what the final product is supposed to do. The specification must be clearly written so that others can understand it.

A concept or idea does not really exist, except in the mind of the originator. One must create operational definitions for the attributes of the product. One cannot simply say "it must measure pressure to a linearity of one percent over a range of 0 to 100 p.s.i."

Rather, it might be necessary instead to specify a test method under which this requirement can be met. There might be, after all, more than one standard for pressure and measurement, and there is certainly more than one definition of linearity. The operational definition serves the powerful function of providing everyone with the same set of rules; basically it levels the playing field.

Sometimes, the operational definition becomes standardized, and is the only way to "get a handle" on the problem. For example, how do you measure the conductivity (G) of water? A marine biologist I knew once tried to dip the problems of an ohmmeter into the water, and then take the reciprocal of the resistance ($G = 1/R$). He was trying to measure salinity. But his results were at odds with other researchers in the same college. They standardized on a method that defined the size, shape, spacing, and material composition of electrodes ... and whadayaknow ... the results were consistent.

Part of making an operational definition is to write a test procedure for the final product. It is here that one determines (and in business often contractually agrees) exactly what the final product will do, and defines the objective criteria of goodness or badness that will be used to judge the product.

Determine Critical Parameters and Requirements

Once the product is properly scoped out, it is time to determine the critical technical parameters that are needed to meet the test requirements (and hopefully the user's needs — if the test requirements are properly written). Parameters such as frequency response, gain, and so forth tend to vary in multi-mode instruments, so one must determine

the worst case for each specification item and design for it.

Attempt a Block Diagram Solution

The block diagram is a signal's flow or function diagram that represents stages, or collections of stages, in the final instrument. In large instruments, there might be several indexed levels of block diagrams, each one going finer in detail.

Apportion Requirements to the Blocks

Once the block diagram solution is on paper, tentatively apportion system requirements to each block. Distribute gain, frequency response, and other attributes to each block. Keep in mind that factors such as gain distribution can have a profound effect on dynamic range. Also, the noise factor and drift of any one amplifier can have a tremendous effect on the final performance — and that it's in these types of parameters (where critical placement of one high quality stage may be sufficient) that added cost and complexity often arise.

Analyze and Simulate

Once the block diagram is set, and the requirements apportioned to the various stages, it is time to analyze the circuit and run simulations to see if it will actually work. A little "desk checking" goes a long way towards eliminating problems later on when the thing is first prototyped. Plug in typical input values, and see what happens on a stage-by-stage basis. Check for the reasonableness of outputs at each stage. For example, if the input signal should drive an output signal to, say, 17 volts, and the operational amplifiers are only operated from five-volt power supplies, then something is wrong and will have to be corrected.

Design Specific Circuits for Each Block

In this step, fill in those blocks with real circuit diagrams.

Built and Test the Circuits

At this point one must actually

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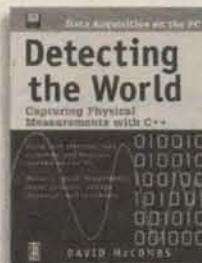
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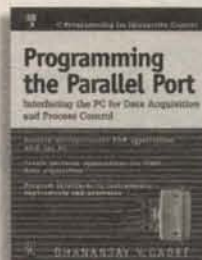
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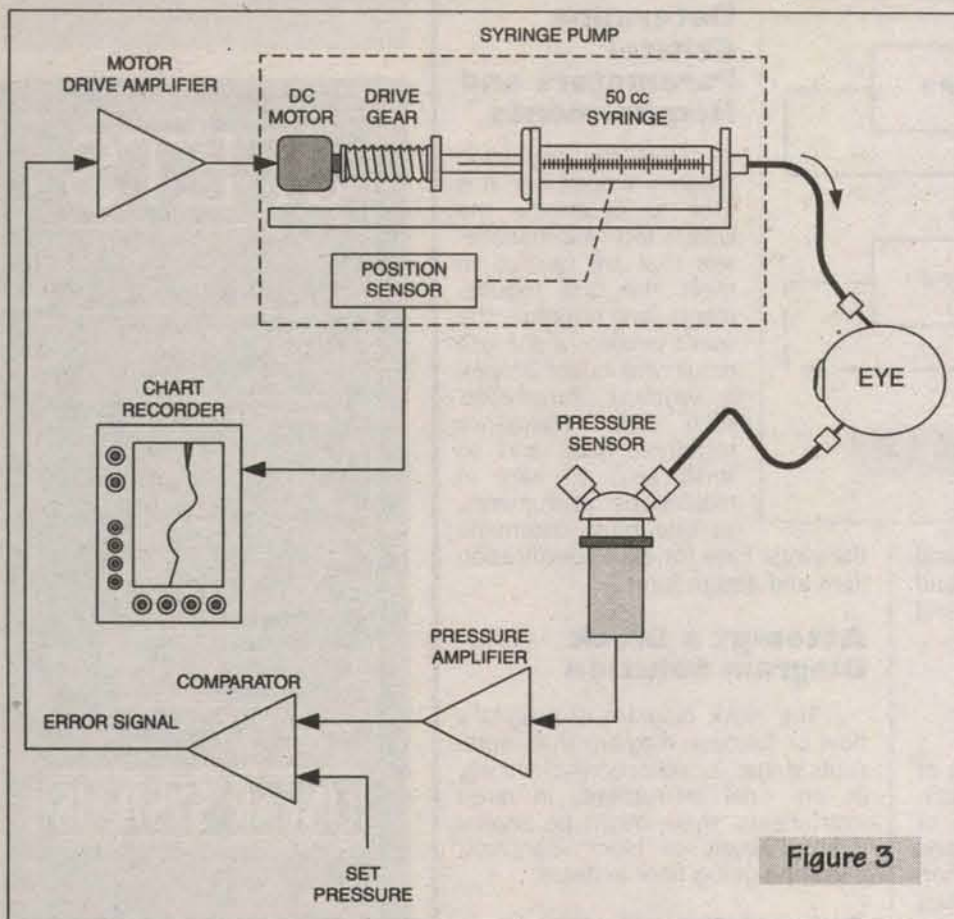


Figure 3

construct the individual circuits, and test them to make sure they work as advertised (unless, of course, the circuit is so familiar that no testing is needed). Keep in mind that some of your best ideas for simplified circuits may not actually work — and this is the place to find out. Use a benchtop breadboard that allows circuit construction using plug-in stripped end wires.

Combine the Circuits in a Formal Breadboard

Once the validity of the individual circuits is determined, combine them together in a formal breadboard. Whether built on a benchtop breadboard (as above), or on a prototyping board, make sure that the layout is similar to that expected in the final form.

Test the Breadboard

Test the overall circuit according to a formally established objective criteria. This test plan should be developed earlier in step two. As problems arise and are solved, make changes and/or corrections — and document the results. It is, perhaps, the main failing of inexperienced designers that they do not properly document their work, even in an engineer's or scientist's notebook. The reason for documenting the process is that it helps when you go back a little while later to make changes, repair the instrument, or even attempt to understand it. It's remarkable how fickle human memory is. It is also necessary to be able to communicate your intent to anyone else who does these chores. If you decide to patent your invention, then the documenta-

tion will help establish your rights.

Build and Test a "Brassboard" Version

A "brassboard" is a version made as close as possible to the final configuration. While breadboarding techniques can be a little sloppy, the brassboard should be a proper printed circuit board. The test criteria should be the same as before, updated only for changes that occurred. If problems turn up, they should be corrected prior to proceeding further. Keep in mind that the most common problems that occur in leaping from breadboard to brassboard are layout (e.g., coupling between stages), power distribution, and ground noise (these are the areas of difference between the two configurations).

Design, Build, and Test Final Version

Once all of the problems are known, solved, and changes incorporated, it is time to build the final product as it will be given to the end user. It is at this point that they reputation of the designer is made or broken, because it is here that the product is finally evaluated by the client.

Deliver, install, and use the instrument!

Parting Words

Whenever you design and build anything — whether it is an electronic instrument, a complex system — or an addition to your house, you need to first capture the requirements. There is no step more important to success! After all, if you don't know what the product is going to do, then you can't even think about making it right. The medical pressure monitor problem mentioned above was basically a requirements capture

problem. The sales rep should've asked the physiologist what he was going to use it for!

I saw another case where an ophthalmology researcher had an engineer design and build a servo pump that could be used to keep the pressure in an animal's eye constant while measuring in-flow (Figure 3). By that method they could measure the eye's out-flow, which was a necessary bit of data for their glaucoma research. The fluid was infused by a syringe pump that was driven by a DC motor, and was modified by the addition of a position sensor that measured the location of the syringe plunger (which told them how much fluid was infused). The pressure inside the eye was measured by a pressure sensor of standard design.

Finally, a comparison amplifier (i.e., a differential amplifier) monitored the difference between a set pressure value and the actual pressure. The difference became an error signal that drove the motor of the syringe pump. Simple, huh? I spent a lot of time modifying the design later on because the engineer did not take into consideration some critical factors.

First, the doctor's office had an even temperature, the lab did not. Drift was huge, mostly from the pressure sensor. Second, the metal used for the syringe pump corroded easily because of the fluid that leaked from the syringe during assembly. Finally, the unit was tested using a lemon as a surrogate for an eye ... and lemons don't have an out-flow facility. As a result, the pump "hunted" because the engineer did not have the opportunity to notice that the AC response of the servo loop was too high.

A little more communication between the user and the designer, and a bit of requirements capture effort might've saved me a lot of trouble later on. **NV**

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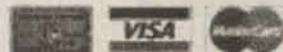
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reader FeedBack

Dear Nuts & Volts:

I am a loyal reader of your magazine and have been for years because of your interesting articles, sources, and columns.

In your Feb. '99 issue, I saw an article about AT&T's decision to stop offering SSB phone service.

This article seems to be geared more towards those users who do not want to give up their faithful SSB systems and not to those who really want reliable inexpensive communications.

The fact is, today's technology offers many options to radio systems at a lower cost and higher reliability and quality.

In the article, the mention of the Inmarsat Mini M alter-

native, makes people fear this system with the warning of high rates and monthly fees. Comsat, for example, has many pricing plans available, many of which do not have a monthly fee.

When compared to \$4.99/min that AT&T use to get in the US, the rates I can offer you with Comsat (as low as \$2.15/min to the US and Canada) are much lower.

Using Mini M also gives you the ability to send and receive basic E-Mail from your computer without extra equipment or modifications.

As for the price of equipment, the \$5000.00+ price you mention is for a complete marine system with a stabilized antenna designed for the rough seas. Less fre-

quent users and those on shore may be able to cover their needs with a portable unit (Our Planet 1 phone is about the size of a small laptop computer) for about \$2,500.00.

I was recently in St. Martin covering the Heineken regatta from one of the race committee boats. During one of the finishes, we were in a bad area for cellular reception and too far for VHF, we were able to use my Planet 1 Mini M phone to call in the race results and even do a live radio interview.

I also used it to send E-Mail from my hotel room on the French side of the island because I could not connect to the strange French telephone system and they wanted about \$4.00 just to connect a call.

Maybe you can do an article on the new satellite technology in the near future. We should let the users see all options available and decide which systems works best for

them. Please visit the Comsat web site at www.comsat.com for more information on Planet 1 (Mini M) and other services available from Comsat. Feel free to contact me with any questions or comments.

Vincent Valldeperas
Comsat Mobile Communications

Hi,

I've just discovered the N&V web site. I don't know if you do any articles on SMD's and SM construction. Perhaps your readers would be interested in my web page at <http://www.billssmd.mcmail.com> I have worked on taming SMD's for hobby use for some years and there is a list of articles on SM on my site, mostly for EPE magazine.

I'll be asking for a trial copy of Nuts & Volts it looks just the job.

Best regards from UK

Bill Mooney
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Build the Pot-Box

by Fred Blechman

Useful to experimenters and circuit designers, the "Pot-Box" allows you to conveniently determine the best value of resistance to use in a circuit, as well as to test various components that must be used with resistance. You can build it for under \$25.00 from all new parts.

The Pot-Box is essentially a potentiometer substitution box. It contains five linear-taper decade-stepped potentiometers, each selected by a rotary switch, and two clip leads. Each "pot" has a pointer knob, so the potentiometer resistance at any position can be estimated. For greater accuracy, the lead resistance can be measured directly.

How many times have you had to hunt through your "junk box" looking for a potentiometer of just the right value when designing, testing, or repairing a circuit? Finally, finding one you hope will do, you precariously perch the "pot" on the workbench and gingerly attach it to the circuit with clip leads. Then, ever so gently (for fear of upsetting the whole "rat's nest" of wires), you rotate the potentiometer shaft.

Sometimes this takes a screwdriver and three hands, but somehow you manage. After trying two or three different potentiometers, you finally find one that's the proper range, and set it to the position that



Box is intended for low-power hobbyist and experimenter circuitry, not Boulder Dam repairs!

Finding the Parts

On the face of it, this seems like a simple project — and it was, over 30 years ago when I designed and built my first Pot-Box. In those days, with Lafayette Radio, Olson Radio, Allied Radio, and other suppliers as a ready source of inexpensive parts for hobbyists and experimenters, it was simple to find the necessary parts at low cost.

Things have changed. There seem to be fewer sources for low-cost parts, and the variety is very limited. RadioShack stocks only the most popular parts. Most mail-order

A Decade Potentiometer Box

gives the desired circuit effect. Now you'll probably want to replace the potentiometer with a fixed resistor — but what value? Out comes the ohmmeter and more lead maneuvering ...

What Is It?

Well, with the "invention" of the "Pot-Box," many of the difficulties just described are eliminated. As

shown in the Figure 1 schematic, the Pot-Box is essentially a potentiometer substitution box. It contains five linear-taper decade-stepped potentiometers, each wired to a rotary selector switch. Two clip leads are the connection to the outside world. Oddly, as useful as I've found this device, no one seems to manufacture one — but you can easily make your own for under \$25.00.

In use, the clip leads are merely

connected to the test circuit, the selector switch is used to determine the potentiometer to be used, and the selected potentiometer knob is turned to vary the resistance. Each pot has a pointer knob, so the potentiometer resistance at any position can be estimated. More on this later.

Note: The potentiometers in the Parts List are rated for 0.4 watts, adequate for today's typical integrated and transistorized circuits. The Pot-

firms have minimum orders and high shipping/handling costs.

When I recently decided to write up my Pot-Box as a project for *Nuts & Volts*, I was dismayed at not being able to find a source for the parts at a reasonable cost. Everyone (including RadioShack) has knobs, switches, clip leads, and cabinets. But finding inexpensive linear-taper decade-value potentiometers of the same type was a real challenge — until I

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All the parts for the Pot-Box are shown
here, and are available from
Tech America.

discovered Tech America!

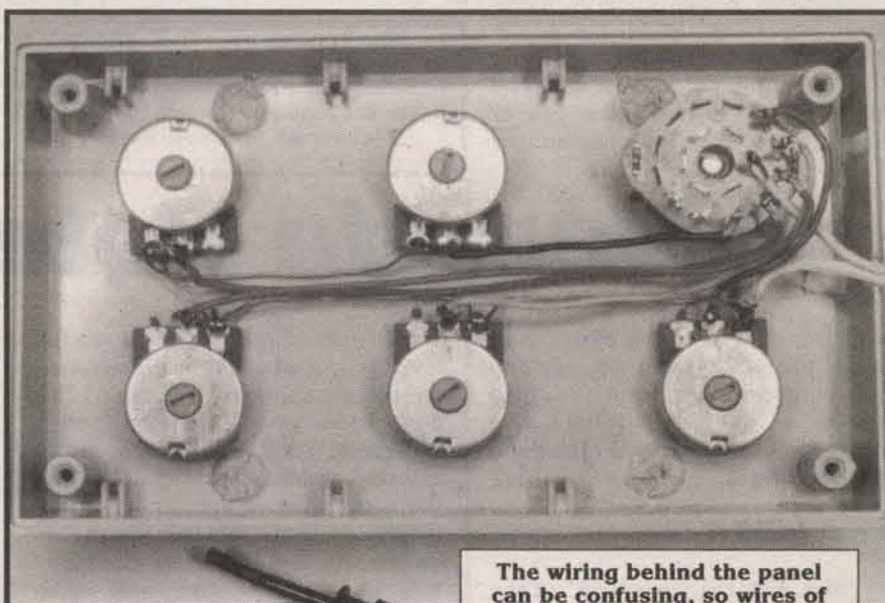
Tech America is primarily a mail-order operation with a huge over-500-page FULL COLOR catalog. They have NO MINIMUM ORDER, with shipping only a flat \$4.00 in most cases! And their large selection of parts is perfect for hobbyists and experimenters.

I found EVERY PART for this project in the Tech America catalog, or their monthly flyers, for a total cost under \$25.00! In particular, the potentiometers are perfect for this project: small, linear, easy to mount, and in decade values — 100 ohms, 1K, 10K, 100K, and 1M — for only \$1.75 each. (Unfortunately, I could not find a similar 10-ohm pot or I would have also used that.)

The rotary switch, cabinet, and knobs were almost as I would have designed them myself for this project — although the rotary switch had one unused position, and the inside of the cabinet needed some minor modifications (described later).

The only electrical parts are the potentiometers and switch. If you order the potentiometers in the Parts List, you'll get the right parts, WITH a mounting nut. When I first ordered the potentiometers for this project, they came without mounting nuts, and the mounting bushing was a METRIC size. I spent hours vainly looking for matching nuts. When I complained to Tech America, they made arrangements to now include the nut with each of these potentiometers. They are REALLY into customer service!

If you should order the potentiometers from another source, make sure they are "linear-taper" rather than the more common "audio-taper." The linear-taper pots have a resistance that varies proportional to their rotation, while audio taper pots as they are rotated follow a logarithmic resistance curve.



The wiring behind the panel
can be confusing, so wires of
different colors are used.

I used subminiature IC test clips to make the external connections, since these have tiny hooks at the end for holding onto small leads. You may prefer regular or mini alligator clips, or you may even prefer to use binding posts on the cabinet.

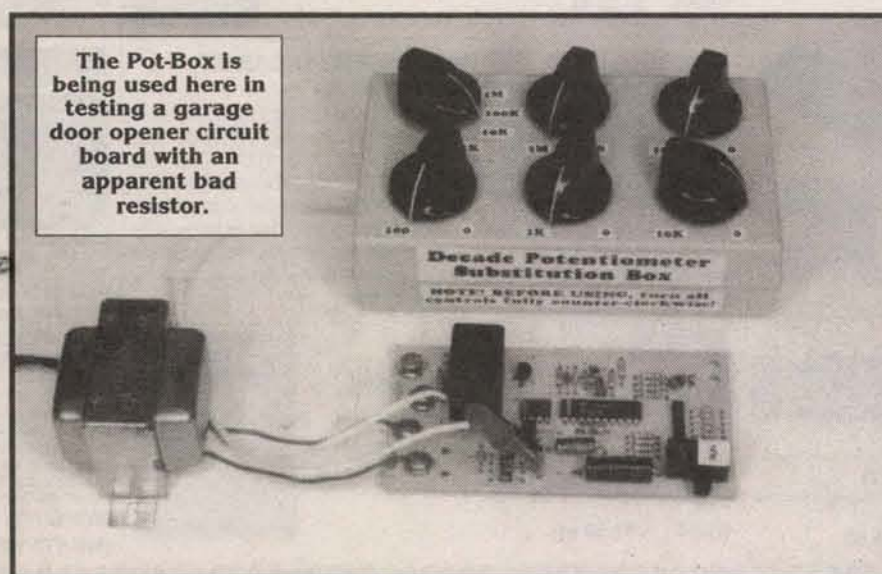
Incidentally, my original over-30-years-ago Pot-Box used dial plates that made it easy to estimate

ingly backward approach of starting with the highest value pot (1M) and ending with the lowest value (100 ohms). But think about it. When using the Pot-Box, you want to start with the HIGHEST resistance (lowest current) for safety, and go to lower resistance (higher current) from there. Therefore, it seems reasonable to use clockwise orientation for increased current. Arguments can be made for other layouts, so suit yourself, since you will be the user.

The entire project is assembled in the upper half of the cabinet. The potentiometers and rotary switch are mounted through holes in the top panel and held in place with the mounting nuts provided.

Looking at the photo of the inside of the Pot-Box, note that the potentiometers and switch can be oriented so that their terminals face toward the center of the box. This simplifies wiring. The switch has a small locking tab to prevent turning; a small hole in the panel is needed for this tab.

The particular BUD cabinet specified in the Parts List has four



The Pot-Box is
being used here in
testing a garage
door opener circuit
board with an
apparent bad
resistor.

internal bosses apparently intended for mounting a circuit board. These interfered with the potentiometers, so using a hot soldering iron, I melted and cut these bosses away.

When wiring, I used bare wire for the "common" connection to each pot. (Looking at the back of the pot, with the terminals at the top, the rightmost terminal is the common for this project.) To eliminate wiring errors to the individual pots, I used a different colored wire (stripped from ribbon cable) between each pot and its center terminal.

Use an ohmmeter to determine the switch terminals for each position. Turning the switch to its full CLOCKWISE position, wire the lowest valued pot (100 ohms) to the active terminal, and then the others in decade sequence. (Using the seven-position switch specified in the Parts List, you'll have two unused terminals.)

Use insulated wire from the wiper terminal of the switch and the potentiometer common connection to the red and black clip leads, P1 and P2. Although there is no real significance here to the black or red test clip, since no polarity is

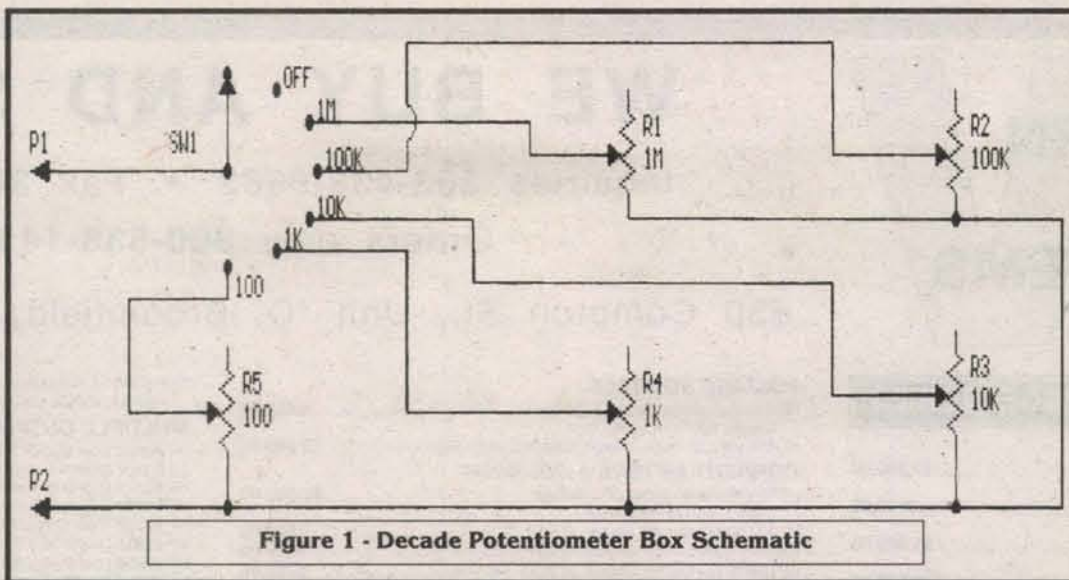


Figure 1 - Decade Potentiometer Box Schematic

involved, I prefer to have the "common" black. A small notch in the edge of the cabinet allows the test clip leads to exit the cabinet.

Now it's just a matter of turning the switch and each pot fully counterclockwise and installing the knobs as shown in the photographs.

Panel markings may be dry-transfer letters, tape labels, or your favorite method. I used a computer desktop publishing program to print the labels, and pasted them to the cabinet with rubber cement.

pots, the knob position gives you a fair indication of value.

Don't be alarmed if your ohmmeter does not show exactly one megohm at one end and zero at the other. These are not expensive, high-accuracy potentiometers.

Once again, I have chosen to start with the highest resistance in the counterclockwise position, so that turning clockwise lowers the resistance. You may prefer to do this the opposite way, in which case you simply wire the common to the OTHER (leftmost) terminal of each potentiometer.

Next, turn the switch to each position and check the resistance reading of each of the pots, both for value and direction of lesser resistance.

Using the Pot-Box

If you are designing a circuit, but not quite sure of the proper resistance to use at a particular place, use one of the pots in the Pot-Box. Set the switch to a pot value higher than your expected resistance and work down from there. After making sure the pot knob is fully counterclockwise, connect the two clip leads from the Pot-Box to the appropriate point in your circuit.

The convenience of the Pot-Box is hard to appreciate until you use it. Since being built over 30 years ago, I've used it repeatedly, from checking meter movements (use a pot in

series with a battery and a known good milliammeter; start with a high value pot and work down), to establishing proper transistor biasing resistor values, finding the right resistance for a desired frequency in an oscillator circuit, and watching the effect of varying the resistance in test circuits of all kinds.

In critical circuits, where a resistance substitution box jumps the gap between the value you need and the next higher or lower box value, the Pot-Box lets you "zero-in" on just the value you

want!

Be aware that the Pot-Box and its leads are not shielded, and may cause oscillation or detuning of high-frequency circuits. Audio circuits should pose no problem.

About the only other precaution you should observe is to stay within the power rating of the potentiometers you use. If you use the suggested 0.4 watt potentiometers, this means not pushing more than about 60 milliamperes through the 100-ohm pot (which only takes 6.0 volts if nothing else is in series) or 20 milliamperes through the 1K pot (about 20 volts). The higher resistance pots would require higher voltages to exceed 0.4 watts.

Still concerned? Then, before connecting the Pot-Box to your circuit, measure the voltage that will be applied to the pot terminals. Multiply that voltage by itself, and divide the result by the maximum pot resistance. The result should not exceed the pot wattage rating. Example: voltage is 9 volts, pot is 1000 ohms; $9 \times 9 = 81$, divided by 1000 equals .081 watts.

Except for the 100-ohm pot, circuits powered by nine-volt transistor radio batteries are no threat, but be careful about how much current you try to shove through the Pot-Box from automobile circuits, which typically draw amperes, or from 117VAC wall power! Although modest in cost and effort to build, the Pot-Box is an experimenter's delight. NV

Parts List

All Part Numbers are from **Tech America**, P.O. Box 1981, Fort Worth, TX 76101-1981. No minimum order, \$4.00 total shipping. Orders: 1-(800) 877-0072; Fax: 1-(800) 813-0087; Support: 1-(800) 876-5292. Internet: www.techam.com.

All potentiometers (R1-R5) are 20mm diameter, 0.4 watts, linear taper, and come with mounting nut. Current price is \$1.75 each:


- R1 - 1M ohm (Tech America 900-5977)
- R2 - 100K (Tech America 900-5974)
- R3 - 10K (Tech America 900-5971)
- R4 - 1K (Tech America 900-5968)
- R5 - 100 ohm (Tech America 900-5965)
- SW1 - Single-pole seven-position non-shortening rotary switch (Tech America 900-7104 \$1.99)
- P1 - Red subminiature test clip (Tech America 910-0229 \$1.30)
- P2 - Black subminiature test clip (Tech America 910-0230 \$1.30)
- Cabinet, 5.63"x3.25"x1.5" (Tech America 910-1245 \$3.74)
- Six Pointer Control Knobs (Tech America 900-2546 \$.64 each)
- Wire, solder, label material

Checkout

Turn all knobs to the extreme counterclockwise position. For the switch, this is straight up. For the pots, this should be at about the seven-o'clock position. Connect an ohmmeter to the test clips. If the wiring is correct, the Pot-Box is OFF, so there should be no resistance reading.

Turning the switch clockwise, the next switch position is also OFF. The next switch position enables the 1M potentiometer. As the 1M pot is rotated clockwise, the resistance should drop from one megohm to about 500K at mid-point, and near zero at the extreme clockwise position.

Since these are linear



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CALIBRATION

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HP 5315A-002,003 100 MHz/100 nS Univ. Counter, batt. power & 1 GHz C-ch.	\$650.00
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option	\$550.00
HP 5315B 100 MHz/100 nS Universal Counter	\$500.00
HP 5316A 100 MHz/100 nS Universal Counter, HP1B	\$600.00
HP 5316A-001,003 100 MHz/100 nS Univ. Counter, HP1B, TCXO, 1 GHz C-ch.	\$750.00
HP 5316B 100 MHz/100 nS Universal Counter, HP1B	\$750.00
HP 5334B-010,060 100 MHz Universal Counter, HP1B, OCXO	\$250.00
HP 5335A 200 MHz Universal / Statistical Counter	\$500.00
HP 5364A Microwave Mixer / Detector, for modulation domain an.	\$3,000.00
HP 5371A 500 MHz Frequency & Time Interval Analyzer	\$1,500.00
PHILIPS PM6666 120 MHz/100 nS Universal Counter, GPIB	\$375.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$250.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$400.00
TEK DC5010 350 MHz / 3.125 nS Universal Counter, TM5000 series	\$950.00
TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series	\$275.00
TEK DC509 135 MHz/10 nS Universal Counter, TM500 series	\$275.00

FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB	\$1,250.00
FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult.	\$500.00
HP 5340A 18 GHz Frequency Counter	\$450.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference	\$3,500.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$3,500.00
TEK DP501 1.3 GHz Prescaler, divide by 16, TM500 series	\$225.00

STANDARDS

HP 105B Quartz Oscillator, 0.1/1.0/5.0 MHz, battery power	\$1,500.00
HP 5061A Cesium Frequency Standard, 0.1/1.0/5.0/10.0 MHz outputs	\$6,500.00
HP 5065A-002 Rubidium Frequency Standard, 0.1/1.0/5.0/10.0 MHz out	\$3,500.00
HP 5087A Distribution Amplifier, 12 outputs at 1 MHz	\$1,500.00
HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz	\$1,750.00
HP 5087A-opt.033 Distribution Amplifier, 12 outputs at 10 MHz	\$1,750.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,500.00
TEK 7L5/L3/R7603 Spectrum Analyzer, 20 Hz-5 MHz, 10 Hz min. res., w/frame	\$1,500.00

DISTORTION ANALYZERS

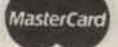
HP 339A Distortion Analyzer, built-in low distortion osc.	\$750.00
HP 8903A-001 Audio Analyzer, 20 Hz-108 kHz, rear panel input	\$1,500.00
HP 8903B-001,013,051 Audio Analyzer, 20 Hz-100 kHz, C-message, CCITT	\$1,750.00
TEK DA4084 Programmable Distortion Analyzer	\$750.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$450.00
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FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz \$450.00

OSCILLATORS

HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max \$225.00
HP 3336C Synthesizer / Level Generator, 10 Hz-21 MHz \$1,400.00
TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz \$2,750.00
TEK SG502 Sine/Square Osc, 5 Hz-500 kHz, 70 dB step atten., TM500 \$200.00
HP 3575A-003 Gain/Phase Meter, 1 Hz-13 MHz, dual display \$850.00
HP 461A Amplifier, 20/40 dB, 1 kHz-150 MHz, 0.5 V/50 Ohms \$125.00

MISCELLANEOUS

KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave \$350.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave \$450.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave \$900.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct. \$600.00
KROHN-HITE DCA-10R 10 Watt Amplifier, 20 dB gain, DC-1 MHz, 600-1000 Ohms \$450.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz \$900.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series \$475.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A \$600.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz \$1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz \$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz \$1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz \$1,400.00
HP 853A-001 Spectrum Analyzer, Display, bench/rack mount config. \$1,250.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. \$4,500.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res. \$8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. \$7,500.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L13/7L14 \$950.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz \$1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 \$600.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz \$1,000.00
HP 4195A Network / Spectrum Analyzer, 10 Hz-500 MHz \$15,000.00
HP 8405A Vector Voltmeter, 1-1000 MHz \$450.00
HP 85020A Directional Bridge, 10-4300 MHz, N(f) test port \$650.00
HP 85021A Directional Bridge, 0.01-18 GHz, APC7 test port \$1,000.00
HP 85021C Directional Bridge, 0.01-18 GHz, N(f) test port \$1,000.00
HP 85025C Detector Adapter, for HP 8757 series \$375.00
HP 85027A Directional Bridge, APC7 test port, 10 MHz-18 GHz \$2,000.00
HP 8502A-H26 Reflection/Transmission Test Set, 4-2600 MHz \$600.00
HP 85044A Reflection/Transmission Test Set, 300 kHz-3 GHz \$1,500.00
HP 8756A Scalar Network Analyzer \$2,500.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series \$1,200.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB \$1,900.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res., GPIB \$1,500.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB \$2,250.00
GIGATRONICS 1018 Synthesized Signal Gen., 50 MHz-18 GHz, 1 MHz res. \$4,500.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB \$2,500.00
GIGATRONICS 600/16-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB \$2,500.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm \$2,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs \$3,750.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res., GPIB \$2,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio \$450.00
HP 3335A Synthesizer / Level Generator, 200 Hz-81 MHz \$4,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm \$3,750.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation \$1,000.00
HP 8656B-001 Synth. Signal Gen., 0.1-990 MHz, 10 Hz res., OCXO ref. \$2,500.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HP1B \$3,250.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod., w/86635A \$2,750.00
HP 8660C/86603A-002 Synthesizer, 1-2600 MHz, FM / Phase Mod., w/86635A \$3,750.00
HP 8672A Synthesized Signal Generator, 2-18 GHz \$6,000.00
HP 8673C Synthesized Signal Generator, 50 MHz-18.6 GHz \$16,500.00
HP 8673G-004, 008 Synth. CW Signal Generator, 2-26 GHz, >+8 dBm output \$12,500.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM, WBFM, Pulse \$3,500.00

SWEEP GENERATORS

HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator \$4,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled \$400.00
HP 8620C Sweep Oscillator Frame \$550.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten. \$1,250.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled \$400.00

HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled \$700.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled \$300.00
HP 86242D-004, 008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled \$300.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled \$500.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled \$500.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled \$500.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled \$1,750.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled \$2,250.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm univld. \$1,250.00
WILTRON 6619A Sweep Generator, 2-8 GHz, +10 dBm levelled \$1,500.00

POWER METERS

ANRITSU MA72B Power Sensor, -20 to +20 dBm, 0.01-18 GHz \$200.00
ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm \$2,500.00
BOONTON 4200-01A, 03/8-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors \$950.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor \$375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor \$500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm \$300.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz \$900.00
HP 435B/8482B Power Meter, 0 to +43 dBm, 100 kHz-4.2 GHz \$1,750.00
HP 435B/8482H Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz \$900.00
HP 436A-002, 022/8481A Power Meter, rear input & HP1B options, with sensor \$1,250.00
HP 8477A Power Meter Calibrator, for HP 432 series \$500.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series \$350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 \$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series \$350.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8 \$1,500.00

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BOONTON 92B-opt.05 RF Millivoltmeter, 10 kHz-1.2 GHz, 75 Ohms scale \$500.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB \$875.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 1W1000 Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output \$650.00
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HP 415E SWR Meter \$200.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms \$125.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output \$375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output \$750.00
HP 8447F Preamp/Power Amplifier, 0.1-1300 MHz \$1,200.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz \$2,500.00
HP 8901B-1, 2, 3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext. LO \$3,000.00
HP 8970A Noise Figure Meter \$4,000.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output \$1,500.00
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BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter \$650.00
CONTINENTAL MW. RAE28-K-M WR28 x K(m) Endfire Adapter \$225.00
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GR 900-Q GR900 14mm Interseries Adapters \$125.00
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HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz \$800.00
HP 3321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm \$475.00
HP 3332L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm \$1,200.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz \$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz \$275.00
HP 778D Dual Dir. Coupler, 20 dB, 100-2000 MHz, N test port \$450.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port \$450.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) \$150.00
HP 8470B Crystal Detector, 10 MHz-18 GHz, neg. pol., APC7 \$250.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA \$150.00
HP 8472B Low Barrier Schottky Det., 10 MHz-18 GHz, neg. pol., SMA \$200.00
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HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA \$350.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA \$400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz \$750.00
HP K281C-012 WR42 x APC3.5(m) Adapter \$300.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18-26.5 GHz \$2,900.00

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HP K914B WR42 Moving Load, 18.0-26.5 GHz \$300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz \$650.00
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HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz \$800.00
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NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) \$165.00
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SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz \$75.00
SPACEK LABS K-2X Frequency Doubler, 9.0-13.25 GHz in / 18.0-26.5 GHz out \$350.00
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TRG B528 WR22 Direct Reading Phase Shifter, 0-360 deg., 33-50 GHz \$1,250.00
TRG V551 WR15 Frequency Meter, 50-75 GHz \$600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz \$750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB \$200.00
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f) \$125.00
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WILTRON 60A50-opt.1 SWR Bridge, 5-2000 MHz, APC7, 46 dB directivity \$450.00

COMMUNICATIONS

HP 4935A-003 Transmission Test Set, 20 Hz-110 kHz, battery power \$600.00
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MISCELLANEOUS

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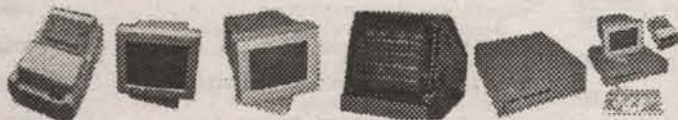
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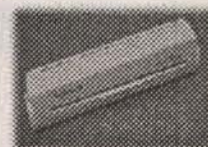
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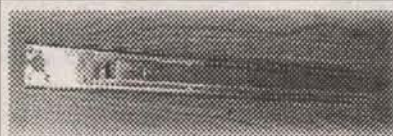
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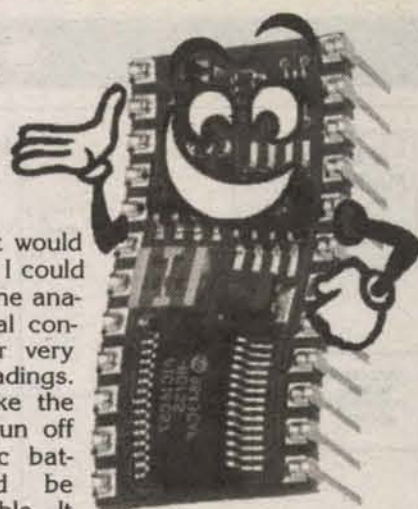
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STAMP APPLICATIONS

by Lon Glazner



Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

One Step Beyond the Application Note

Overview

Application notes are generally a good starting off point for many designs. It's always nice if you can learn from example. There's nothing wrong with learning from your own mistakes, but it's usually beneficial if you can avoid as many as possible. More importantly, there's no reason to re-invent the wheel, especially in electronic engineering.

I'd like to share with you a process that I use when starting a design, and then walk you through an example. When I'm embarking on a design that utilizes an IC or processor that's new to me, I try to ensure that I do three things before any actual design work begins.

First, I download or order the data sheets for the part in question. If the part is not going to meet your design requirements, you will probably find this out by reading the first few pages of the data sheet.

The general description on the first page is usually a glowing report detailing all of the wonderful things that the device can do. This description overtly avoids any discussion of a particular part's shortcomings. Rest assured the information is available, it's just not on the front page. What you can find out from the general description are the key features of a product. If these features seem to meet your design's needs, then you've cleared the first hurdle.

Next, check the maximum ratings of the part in question. Supply voltages, operating current, and operating speeds can all be found either in the maximum ratings section or in the electrical characteristics that usually follow in table form. When dealing with families of parts that are all fairly similar, the manufacturer usually has a selector guide with a cross-reference. This selector guide can be useful in weeding out undesirable parts.

Second, once a cursory overview has shortened the parts list, I always search for application notes that reference the parts I am interested in. Often times, the list of application notes is pretty large. This is the case with the BASIC Stamp. Not only does Parallax provide application notes and

kits for use with the BASIC Stamp, there are also third party sources for application notes (see Figure 6).

Sitting down and actually reading all of the application notes for a particular product would be time consuming and inefficient. I definitely don't recommend that path to anyone. But it is usually a good idea to familiarize yourself with the application notes that are available. Being able to reference source code or connectivity information from an application note can cut hours out of your design time, and reduce the possibility of errors in the final product.

The third — and final — step in the process of selecting a chip is to look for an errata sheet for the part. An errata (error-data) sheet will usually state errors in the original data sheets and/or provide updates due to bugs in the part's silicon. These can KILL you. Primarily because they won't be listed in hard copies of the data sheet that you might already have. This allows functional problems to seep into your design or create hours of misguided debugging attempts. Always look for an errata sheet! Most manufacturers make these available as soon as the problem is defined. I also check to be sure that any part I am selecting has not been placed on an obsolete part list. There's nothing worse than completing a design that can't be produced.

For the Stamp enthusiast, some of this stuff doesn't matter. For example, if you're designing a pump controller for your fish tank, you're better off using what you have on hand. In other words, who cares if you're using an obsolete part, if it's free and already in your tool box, you might as well use it.

Defining The Design

I just started designing a new product. In our company, we usually go through a complete paper design, cost estimate, and functional overview prior to any parts hitting the breadboard. I'm still in that paper design phase but, of course, I'm looking ahead at the testability of my prototype. And that's where the BASIC Stamp comes in.

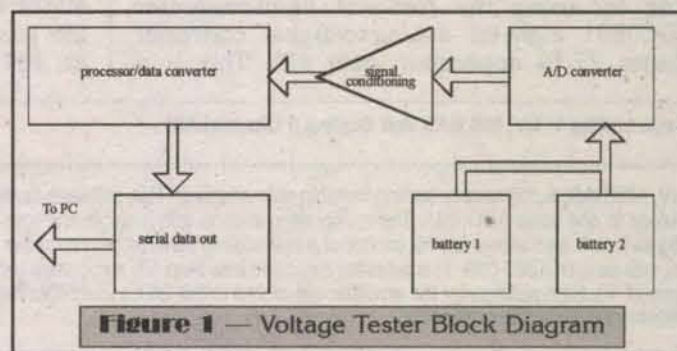
I need a device that will take voltage measurements of a single AA NiCad battery. Initially, the accuracy of the measurement doesn't need to be that stellar.

But later it would be great if I could fine tune the analog-to-digital conversion for very precise readings. I would like the tester to run off of a 9Vdc battery, and be semi-portable. It should also be expandable. For starters, I need to measure at least two voltages; future expansion of up to six voltages is desirable. The voltage data should be transferable to a PC for graphical analysis. And finally, I would like to be able to adjust the period between voltage measurements (the sample period). If I were to list the functions I'm looking for they would appear as they do below.

- Eight-bit analog-to-digital (A/D) conversion
- 2-6 A/D measurements
- 0-2Vdc range for each measurement
- Single supply derived from 9Vdc
- Serial data capability
- Adjustable sample period

Beyond the functional description, I need to be a little concerned about pricing. This is a test set-up for a product that may or may not go into production. So spending too much on the set-up would be a bad idea. In that same vain, spending too much time on the design would tend to eat up company resources. To me, this design has BASIC Stamp written all over it. It's usually good to have a block diagram of all functionality in a design. Figure 1 is the initial block diagram that I came up with.

There are a couple of things that immediately become apparent from the block diagram. The first is that the BASIC Stamp can suffice as both the processor/data converter and the serial data



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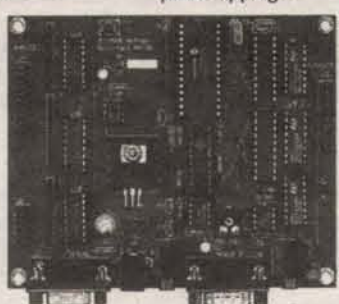


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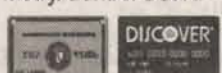
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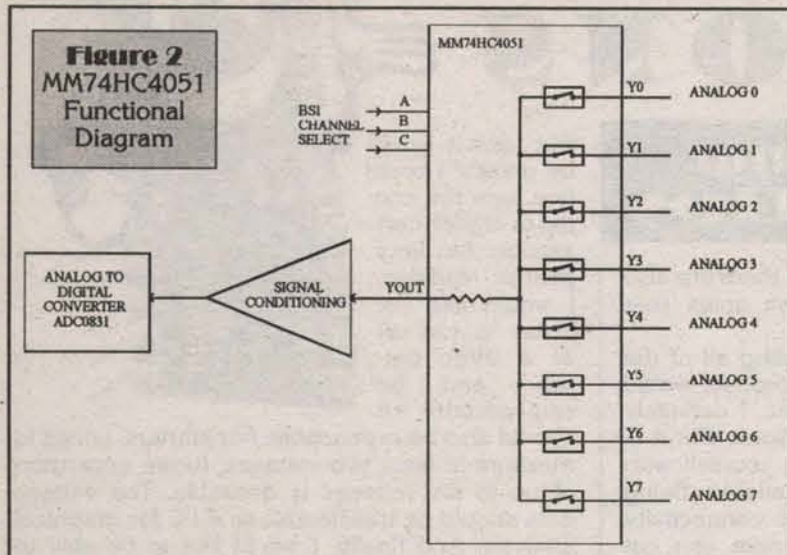
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STAMP APPLICATIONS

Figure 2
MM74HC4051
Functional
Diagram



out block. I want the data to be sent to a PC in ASCII format. In this way, I can easily read it as a terminal program displays the data. This should also be something that the BASIC Stamp can accomplish.

I also realized from the block diagram that I will either need multiple A/D converters or some means of multiplexing the analog signals onto a single A/D. The latter concept is the least costly in parts so, for now, I'll be leaning towards that method. This device will likely require some conditioning of the analog voltage to be measured. The signal conditioning may be filtering, amplification, just plain buffering, or all of the above. To further minimize pricing, I'll be using the BASIC Stamp I (BS1). Most, if not all, of the functionality I desire can be derived from the BS1. So, at this point, I went to work scribbling furiously and perusing data sheets, and this is what I came up with.

Analog Multiplexing

Here's where the application notes come in. I know from being familiar with my Parallax BASIC Stamp manual that there is an application note for using the National Semiconductor ADC0831 eight-bit analog-to-digital converter (pages 77-79 application note #2). This is a

single supply, single channel, eight-bit A/D. I just happen to have a few of these lying around, so that definitely fits my budget.

These parts utilize a serial data protocol that is compatible with NSC MICROWIRE, and is easily interfaced to the BS1. Since these parts can share serial data and clock lines, I could easily just hook-up six ADC0831 and, with a little "glue logic," I could select the A/D I want to read a voltage from with the BS1. But not only would this require multiple A/Ds, I would also have to duplicate my signal conditioning for each A/D. There is a

better way. With a low-cost chip — the MM74HC4051 from Fairchild Semiconductor — I can multiplex up to eight analog signals onto a single A/D device.

Figure 2 is a functional diagram of how the MM74HC4051 fits into the circuit. With this chip, you can easily multiplex analog signals to a single A/D converter. There is an internal resistance that is associated with each switch. This creates the need for the signal conditioning circuit to possess at least a voltage follower as its first element. More discussion on this comes later. The logic family that I chose allowed signal levels from +6Vdc to -6Vdc to be passed by the analog switch. There were other forms of this chip (different logic families) that could operate off of +15Vdc, which I have to say intrigues me. But I'll leave that for a later date.

Signal Conditioning

As mentioned earlier, the analog multiplexer requires a voltage follower, or buffer, to ensure that the next section of my signal conditioning is not affected by the analog switch resistance. In reading through the data sheets for the MM74HC4051, I noticed that the resistance of the analog switch varies with the input voltage, as well as the voltage differential between the

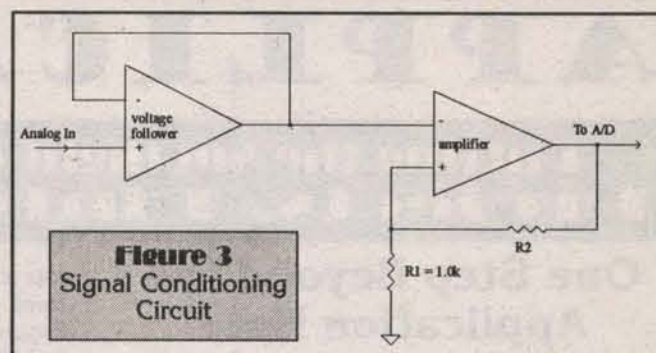


Figure 3
Signal Conditioning
Circuit

lower rail of the analog switch and its upper rail. This kind of characteristic is what you should look for in the data sheet. It tells me that unless I isolate this resistance from any filters or amplifiers, I will probably lose some accuracy in my measurements.

I chose the signal conditioning circuit in Figure 3 for a couple of reasons. The previously mentioned analog switch resistance explains the voltage follower. But the voltage follower is also in place to prevent the analog switch resistance from affecting the gain of my amplifier block. I realized early on that if the eight-bit A/D was measuring over a 5Vdc range, and my input signal was less than 2Vdc, about half of the A/D's measurement range would be unused. For that reason, I included a non-inverting amplifier stage. The gain for this amplifier can be defined as $1 + R2/R1$. For instance, if I set R2 to 1.0K ohms, then my gain would be $1 + (1000/1000) = 2$. So if my input signal was 1.5V, the signal I would be measuring would be 3.0V.

It was at this point in the design that I recalled a BASIC Stamp application note written by Scott Edwards, of Scott Edwards Electronics fame. Scott also used to write this column for *Nuts & Volts*. The application note that I'm speaking of described the Dallas Semiconductor DS1267 digital potentiometer, which just happens to use a serial interface similar to the ADC0831. Since both of these devices use the same communication interface, it's feasible to place them on the same bus (share the clock and data lines). Furthermore, it dawned on me that by replacing R2 in the signal conditioning circuitry with a digitally-controlled potentiometer, I could have an intelligent amplifier. This amplifi-

Code Listing 1: NV_499.BAS Self Scaling 8 Channel A/D

'NV_499.BAS: Automatically scaling variable gain amplifier. This software multiplexes 8 analog input values to one serial ADC0831. The multiplexing is done with a single low cost MM74HC4051 analog switch. It also allows for the control of a self scaling variable gain amplifier based on an LM358 as well as a DS1267-010. This amplifier exhibited less than 5% error when using its maximum gain of 10. Gain settings for the amplifier are stored in the BS1's EEPROM memory, and were determined in the lab empirically.

'BS1 Pin Definitions:

SYMBOL	CLK	= 7	'Serial clock line
SYMBOL	DAT	= 6	'Serial data line
SYMBOL	DATpin	= pin6	'Symbol for data line pin
SYMBOL	CS_AD	= 5	'Chip select for ADC0831
SYMBOL	CS_POT	= 4	'Chip select for DS1267-010
SYMBOL	SDATA	= 3	'Pin reserved for serial data output
SYMBOL	C	= 2	'A/D channel select MSB pin
SYMBOL	B	= 1	'A/D channel select pin
SYMBOL	A	= 0	'A/D channel select LSB pin

'BS1 Variable Definitions

SYMBOL	DSpots	= W0	'Word variable for DS1267-010 dual pot settings
SYMBOL	DSpots0	= B0	'Pot 0 settings variable
SYMBOL	DSpots1	= B1	'Pot 1 settings variable(not used in this code)
SYMBOL	AD_sel	= B3	'A/D channel select variable
SYMBOL	Clocks	= B4	'Clock bit counter variable for serial communication
SYMBOL	AD_in	= B5	'A/D input variable used to store A/D measurements
SYMBOL	Gain	= W3	'Stores EEPROM address of pot settings for various gains
SYMBOL	AD_data	= W4	'Displays voltage in 100's of micro-volts

START:

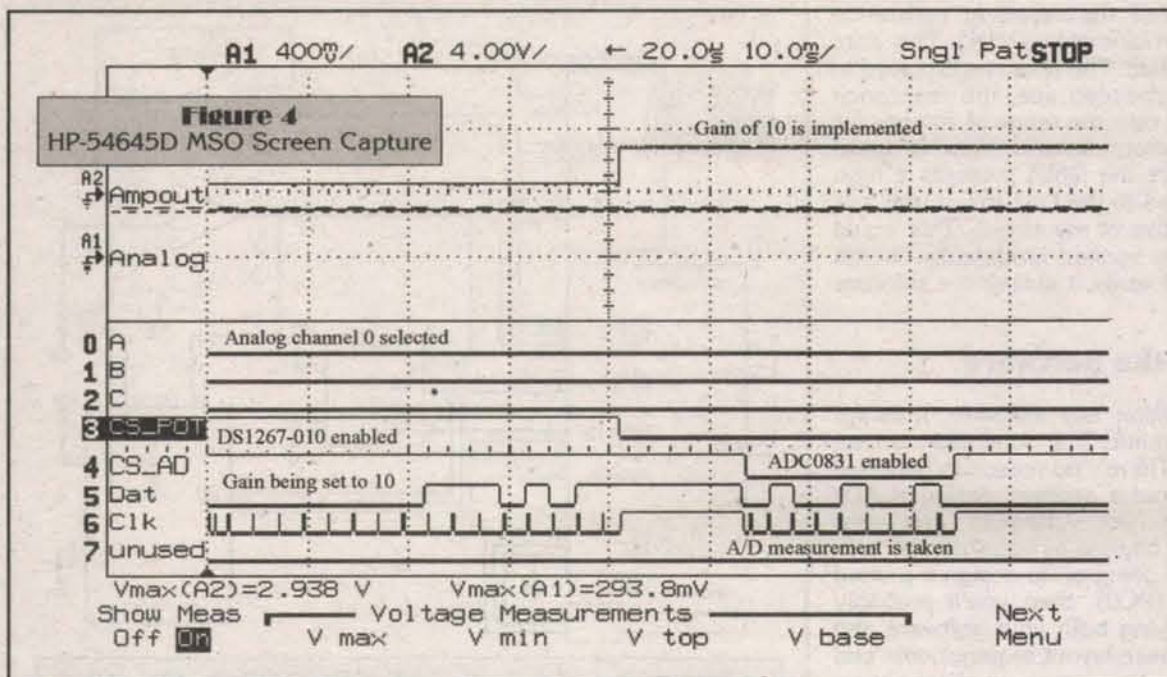
WRITE	8,235	'Pot 0 setting for a gain of 10 stored at EEPROM address 8
WRITE	7,214	'Pot 0 setting for a gain of 9 stored at EEPROM address 7
WRITE	6,186	'Pot 0 setting for a gain of 8 stored at EEPROM address 6
WRITE	5,158	'Pot 0 setting for a gain of 7 stored at EEPROM address 5
WRITE	4,126	'Pot 0 setting for a gain of 6 stored at EEPROM address 4
WRITE	3,98	'Pot 0 setting for a gain of 5 stored at EEPROM address 3
WRITE	2,66	'Pot 0 setting for a gain of 4 stored at EEPROM address 2
WRITE	1,38	'Pot 0 setting for a gain of 3 stored at EEPROM address 1
WRITE	0,10	'Pot 0 setting for a gain of 2 stored at EEPROM address 0

GOSUB	ANALOG	'Load first analog measurement
AD_SEL	= 0	'Pre-set A/D channel to 000
PAUSE	1000	'Allow a little time for power up

BEGIN:		
GOSUB	SELECT_AD	'Select A/D channel with pins A,B,and C
GOSUB	SET_GAIN	'Set gain and take A/D measurement
GOSUB	TRANSLATE_DATA	'Translate data into 100's of micro-volts and display
GOTO	BEGIN	

'SELECT_AD: This subroutine cycles through the 8 different analog channels. The pin values are 'reset with each pass through to ensure that the correct A/D is selected. The channel being 'accessed is located in the variable AD_sel.

SELECT_AD:		
PINS	= %11101000	'Clear lowest three bits, pins A,B, and C
PINS	= PINS + AD_sel	'Add AD_sel(0-7) to PINS register
DEBUG	AD_sel	'Display current channel selected
AD_Sel	= AD_sel + 1	'Increment channel number for next time through
IF	AD_sel = 8 THEN Zero_AD_sel	'Make sure AD_sel never exceeds 7
RETURN		
Zero_AD_sel:		



er could scale its gain up or down for more accurate measurements. Now things started to get interesting.

Before going any further, I needed to select a low-cost operational amplifier (op-amp) for my signal conditioning circuit. Ideally, the op-amp should come in a dual or quad pack (two or four op-amps per chip). It should also be capable of single supply operation. Finally, an op-amp with rail-to-rail output (output ranges from roughly 0Vdc to +5Vdc) would be desirable to give me access to the full range of the A/D's eight-bit measurement.

There are a handful of other important characteristics useful in selecting an op-amp. These range from operating current to gain-bandwidth. Since I'm just amplifying DC voltages, most other characteristics are not entirely relevant to my design. I found a National Semiconductor part — the LM358 dual op-amp — that seemed to fit the bill for this design. In choosing this part, I opted to live without a rail-to-rail output. This is just another example of the kind of trade-off you

typically make during a design. I made sure that this part was pin-for-pin compatible with other rail-to-rail output op-amps in case I changed my mind at a later date.

The DS1267 digital potentiometer that I used was the 10K ohm version. There's a bit of a trick to using these parts for a design like this. When I first used this part, I measured the resistance across the part at both of its end points (with the pot set to 0 and 255 by the BS1). I found the resistance ranged from 500 to 9500 ohms. This led me to deduce that the wiper resistance was roughly 500 ohms. In reading the data sheet, I found that the wiper resistance for these parts can range from 400-1000 ohms. The actual resistance exhibited is related to the voltage at the wiper, which is related to the setting of the digital pot. But guess what, there's no place in the data sheet that actually described how this resistance was related to the voltage on the wiper. This required a little lab work.

I modified the DS1267 application note to step through resistance settings in steps of 10,

Online Sources for Application Notes:

The following companies and individuals provide online application notes for use with the BASIC Stamp. If you're looking for a forum to ask questions about BASIC Stamps, try joining the Stamp List that is hosted by Parallax. You can find out more about this list at Parallax's website.

Parallax — www.parallaxinc.com

Parallax created the BASIC Stamp. BASIC Stamps, application notes, third-party products, and kits are available from Parallax.

Nuts & Volts — www.nutsvolts.com

Nuts & Volts provides copies of the Stamp Applications article all the way back to 1996 at their website.

Solutions Cubed —

www.solutions-cubed.com

Solutions Cubed provides application notes for Miniature Engineering Modules to be used with the BASIC Stamp.

Scott Edwards Electronics —

www.seetron.com

Scott Edwards Electronics has application notes, products, and kits all for use with the BASIC Stamp.

Al Williams (AWC) — al-williams.com

Al (AWC) provides the Stamp Project of the Month, as well as an FAQ list and products for use with the Stamp.

Bob Blick —

www.bobblick.com/bob/stamp/

Bob's got quite a few cool applications for BASIC Stamps, as well as a site ripe with interesting uses of technology.

Beau Schwabe —

www.ionet.net/~bschwabe/index.html

Beau's one of the resident answer guys on the Stamp List; he's also got a list of application notes longer than my arm..

```

AD_sel = 0          'Return AD_sel to 0
RETURN

*****
'TRANSLATE_DATA: This subroutine translates the A/D data into a value in 100's of micro-volts.
'This is done to retain maximum resolution of the measurement. Simply divide the result returned in
'AD_data by 10,000 to determine the measurements value in volts.

TRANSLATE_DATA:
LET AD_Data = AD_in * 196 'Scale up A/D measurement by 10E3*8 bit A/D step(19.6mV/step)
LET AD_data = AD_Data / Gain 'Divide measurement by Gain value (10 to 2)
DEBUG AD_data,CR 'Display result to debug screen
RETURN

*****
'SET_GAIN: The SET_GAIN routine cycles through the gain values from 10 to 2. Any measurement
'that is returned that is below the upper rail of the op-amp is considered valid. The LM358 upper rail
'is 3.5V. With a minimum gain of two the greatest voltage that can be measured is 1.75Vdc. By
'changing to a rail-to-rail output op-amp such as the LMC6132 this range can be increased to
'2.5Vdc. A voltage divider could also scale down voltages, and allow larger voltages to be measured.

SET_GAIN:
Gain = 9 'Start gain test at (9-1+2) or 10
Gain_test:
IF Gain = 0 THEN Done_with_gain
LET Gain = Gain - 1
READ Gain,DSpots0 'Check for minimum gain setting
GOSUB OUTPUT 'Subtract one from exiting Gain register
GOSUB ANALOG 'Use result as address pointer for EEPROM READ
IF AD_in > 178 THEN Gain_test 'Set potentiometer to desired gain level
Done_with_gain: 'Read analog to digital converter
LET Gain = Gain + 2 'Test for value greater than 3.5V(op-amp upper rail)
DEBUG Gain,CR 'Actual gain is Gain reg. + 2
PAUSE 10 'Display Gain selected
RETURN

*****
'OUTPUT: This subroutine was taken directly from a Scott Edwards application note. It is also simi-
'lar to the analog subroutine except that 17 bits are transmitted.

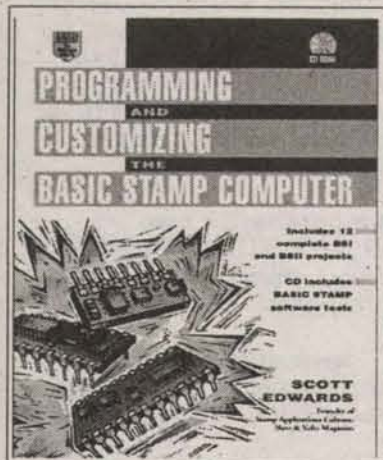
OUTPUT:
LET DIRS = %11111111 'Make all pins outputs
HIGH CS_POT 'Select DS1267-010
LOW CLK
LOW DAT
PULSOUT CLK,10
FOR CLOCKS = 0 TO 15
LET DATpin = BIT15
PULSOUT CLK,10
LET DSpots = DSpots * 2
NEXT
LOW CS_POT
HIGH CLK
PAUSE 10
RETURN

*****
'ANALOG: This subroutine was taken directly from the Parallax application note #2 from their data
'sheet. Notes on this application note can be found on pages 77-79 of the Parallax BASIC Stamp
'data book.

ANALOG:
LET DIRS = %10111111 'Make DAT pin an input
LOW CLK
LOW CS_AD 'Select ADC0831
PULSOUT CLK,10
LET AD_in = 0
FOR CLOCKS = 0 TO 7
LET AD_in = AD_in * 2
PULSOUT CLK,10
LET AD_in = AD_in + DATpin
NEXT
HIGH CS_AD 'De-select ADC0831
HIGH CLK
RETURN

*****END:
'End of program space
    
```


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STAMP APPLICATIONS

and I measured the resulting resistance with a digital multimeter (DMM). This data was then graphed. The result is displayed in Graph 1. As you can see, the resistance remains linear over the range of settings for the digital potentiometer. This is good news, but since the DMM presents a high impedance load to the DS1267, it may not be representative of my circuit. This would still have to be verified empirically. Which means I could verify it during the software design.

Designing the Software

Before writing any software, I always create a schematic. The schematic is usually in pencil. There's no reason to generate it with a computer assisted design (CAD) program just yet. Chances are your schematic will change as you write the software. If you're going on to design a printed circuit board (PCB), then you'll probably end up modifying both your software and schematic to ease layout requirements and reduce noise.

It's also a good idea to generate a flow chart of some sort for your software prior to sitting down to write it. Quite often my BASIC Stamp

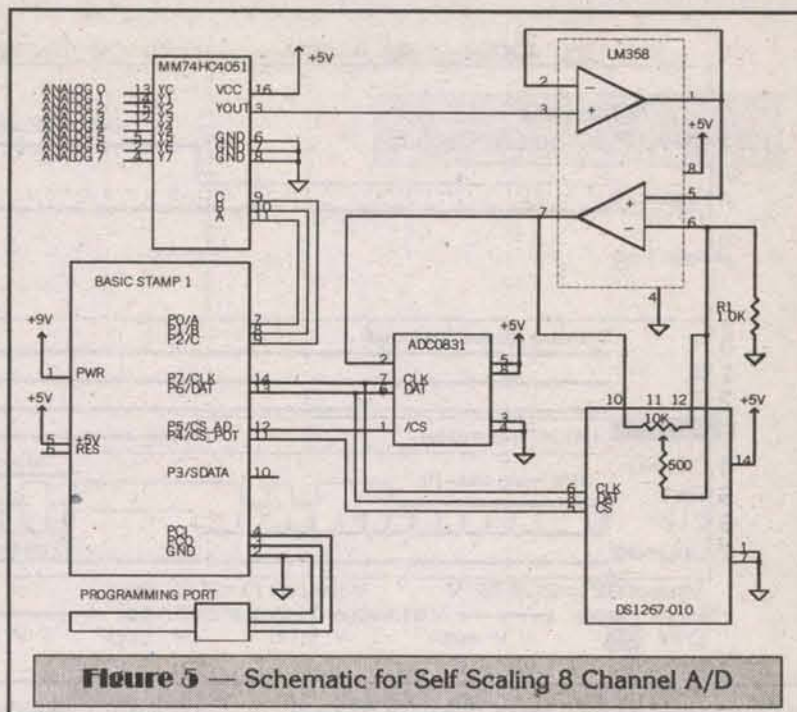
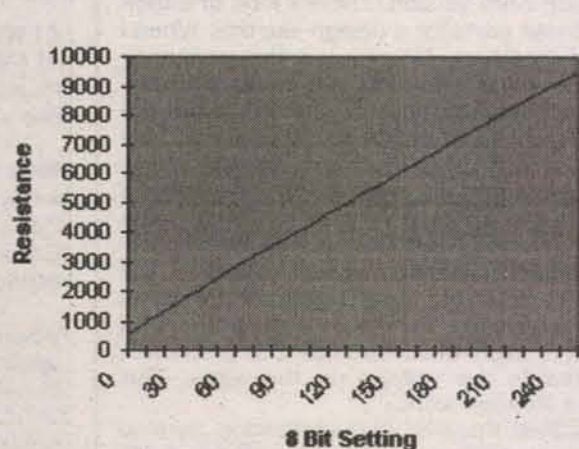


Figure 5 — Schematic for Self Scaling 8 Channel A/D

DS1267-010 Resistance VS. Setting



programs are relatively short. For this reason, I often forego the flow chart in lieu of a list of subroutines. If your program is long and has quite a few branches, gosubs, or gotos, then flow charting before and after you write the software is something I would recommend.

Originally, I had envisioned being able to set the gain of the amplifier block in my software with an equation. But, in the end, I opted for maintaining the gain settings by storing them in EEPROM. The BS1 Write and Read commands make it simple to implement indirect addressing to access stored constants. This also allowed me to modify the potentiometer settings to exactly match desired gain values.

During initial testing, I've found that the voltage measurements are typically within 2-3% of the actual voltage. It would be possible to utilize both of the potentiometers in the DS1267-010 in order to increase the resolution of the gain setting function. Doing this would remove some of the error exhibited by this voltage measurement technique. It would also be possible to have a

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reference voltage at one of the analog inputs.

By using a known reference voltage, a sub-routine could easily be written that would adjust the gain values to be stored in EEPROM to the correct values. For instance, with a reference voltage fixed at 250mV, the routine could set the gain to 2 and adjust the potentiometer value up or down until the A/D reading was closest to 500mV. This new value could then be stored in EEPROM. This could continue until all gain values have been modified. Afterwards, the regular program would commence. This kind of self-adjustment would be useful in removing errors

induced by temperature fluctuations or component tolerances.

This kind of system can be easily devised with the versatile BASIC Stamp. The source code used for this design is listed in Code Listing 1: NV_499.BAS.

The software was simplified considerably due to the inclusion of both of the application notes provided by Parallax and Scott Edwards. Other than a little research, and some short sub-routines, this design was painless. There's still some work to be done as far as getting the voltage measurements into a PC. And guess what? There's an application note for that described in the Parallax BS1 SEROUT command (pages 63-65 of the BASIC Stamp manual). I haven't yet implemented the serial communication routines, although this should not pose a problem. It is most likely that I will use a quickBASIC program to store and convert the incoming data. The resulting data file will then be opened with Microsoft Excel and the data will be graphed.

Figure 4 provides an oscilloscope screen capture of both the gain setting and the A/D measurement. You can actually see the communication to the DS1267-010 and the resulting increase in the amplifier's gain. This is followed closely by the A/D measurement. The analog channel 0 input is measured by the oscilloscope as 293.8mV. The output of the op-amp amplifier is 10 times the voltage at analog channel 0, or 2.938V. These measurements are displayed at the bottom of the screen capture.

The oscilloscope used was the Hewlett Packard 54645D - MSO. This oscilloscope has some neat features that allow you to monitor digital lines like a logic analyzer would, as well as display the analog channels.

Figure 5 is a schematic of the finished project. Keep in mind that the serial output has not been completed, but I left a pin available for this function. The sample rate is also not adjustable at this point, but simply adding a PAUSE command, or increasing the ones already in the program would suffice as an adjustable sample rate.

In Closing

It was my hope to show a couple of things in

this month's column. Primarily, I wanted to emphasize the use of application notes in engineering. Usually you can find an application note that can answer some of your questions, and point you in the right direction. I run into people now and again that expect to find an application note that will fit their needs, and solve all of their design woes. That's just plain unrealistic.

When working with electronics, you can expect to face certain hurdles. In many cases, somebody has already cleared the hurdle that you can't seem to get over. If it's a common problem, there may be an application note for solving it. If it's an uncommon problem, there's only one thing you can do. Get out your tools, engineering resources, pencil, and paper, and get to work. Whether your efforts culminate in success or failure, you're bound to learn something, and that's not a bad thing.

The design completed here was accomplished with two application notes, both of which were nearly identical. It took a little creativity, and a few hours of research but, in the end, it's something that I can use in the lab. There were no revolutionary concepts derived from integrals or squeezed out of linear algebraic functions. I'm not going to show up at the next COMDEX with 10,000 units of BS1-based battery voltage testers and make a mint with this design.

What I did do was build something that would help me get my design work done, and hopefully allow me to build a better product. And I think that's the true power of the BASIC Stamp. It allows you to put technology to work at a minimum cost. Not to mention I tend to get a kick out of the idea that that little BASIC Stamp is making decisions and cranking out precise analog measurements while I type away at the PC. And I don't have to pay it a dime. NV

.....
Lon Glazner is a partner and Engineer at Solutions Cubed. Solutions Cubed is an innovative group of design engineers who specialize in embedded control design. They also produce a line of BASIC Stamp compatible products called Miniature Engineering Modules.

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THE 'OPTO' IN OPTOELECTRONICS (Part 2)

Most of last month's opening episode of this mini-series described the basic nature and behavior of light, with particular regard to its use in modern optoelectronic systems. The remaining part of that episode dealt with two types of light-beam manipulators, namely, mirrors and retroreflectors.

This month's episode continues the 'light-beam manipulators' theme by describing the nature and behavior of optical prisms and lenses.

LIGHT-BEAM MANIPULATORS

PRISMS

In optics, a prism is a block of transparent material having two or more plane (flat) surfaces. Prisms have an innate ability to bend the paths of light. A flat sheet of glass is a very simple prism.

When light travels through a transparent material or medium other than free space, its velocity (v) and wavelength (λ) are lower than those that pertain in free space (v_0 and λ_0). The ratio v_0/v or λ_0/λ is known as the medium's *refractive index*, and is denoted by the symbol n .

Figure 1 lists some typical n values for various transparent media, including normal glass ($n = 1.5$ to 1.9), which is transparent to all visible light and much of the lower IR spectrum, but blocks most of the UV spectrum.

Figure 2 illustrates the effects that 'refraction' has on a light ray when it travels through a pane of glass with (for simplicity) an n value of 2. In Figure 2(a), the beam enters the glass at an incident angle of 0° , is slowed down (thus reducing the light's wavelength, but *not* its frequency) as it passes through the glass, and then returns to normal 'through air' speed as it leaves the glass at an angle of 0° .

In Figure 2(b), the dashed lines represent the *normal* or zero degrees angular reference line. In this diagram, the ray enters the glass at an incident angle (α_i) of (say) 30° and then, as it passes from the thinner medium (air) to the denser one (glass), the ray *bends towards the normal* by a refractive angle (α_r) of about 15° ; when the ray passes from the

denser to the thinner medium again as it leaves the glass, the ray *bends away from the normal* again, returning to its original angle of 30° , thus obeying the basic Laws of Refraction. The values of α_i , α_r , and the n values of the incident (n_i) and refractive (n_r)

the same glass surface — are subject to this type of parallax error.

Most prisms have plane surfaces that are angled away from each other, as shown in Figure 3, in which two prisms each have their major surfaces angled at 30° to one another. This diagram

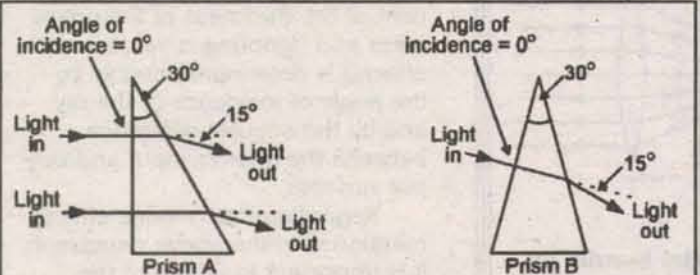


Figure 3. Diagram illustrating some important ray-bending features of a simple prism.

Substance	Refractive Index
Free Space	1.000 000
Air	1.000 293
Ice	1.31
Water at 20°C	1.333
Glass	1.5 to 1.9
Diamond	2.42

Figure 1. Table listing typical refractive index values for various transparent media.

regions are related by Snell's law of refraction, which states that $n_r/n_i = \sin \alpha_i / \sin \alpha_r$.

Note in Figure 2(b) that the light ray leaving the glass is shown parallel with — but offset from — the path of the original input ray, which is indicated by the dotted line. The degree of offset (parallax error) increases with the angle of incidence and with the thickness of the glass. Simple mirrors — in which light rays enter and leave the mirror via

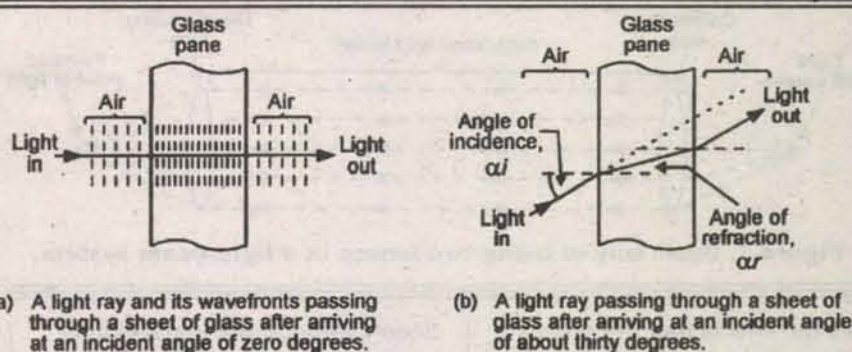


Figure 2. Diagrams illustrating the effects of refraction through a sheet (pane) of glass.

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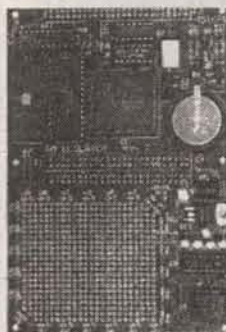


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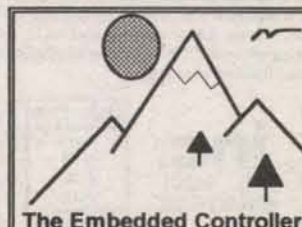
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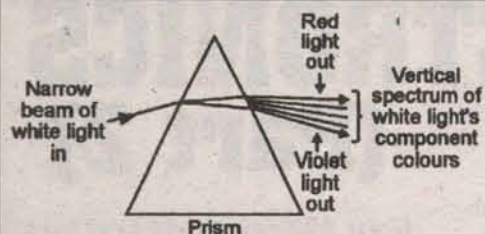


Figure 4. Exaggerated diagram showing a prism splitting a beam of white light into its component colors.

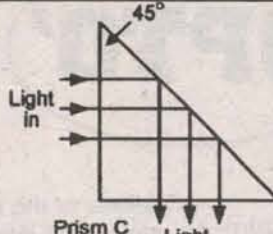
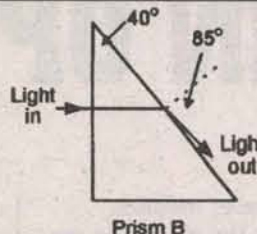
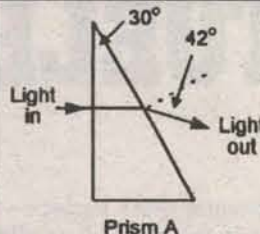


Figure 5. Diagram illustrating the phenomenon of total internal reflection in a prism.

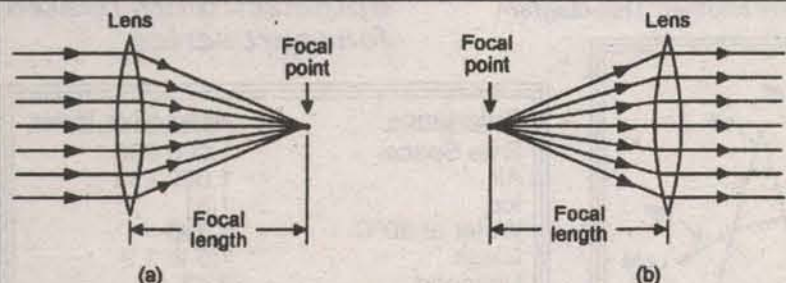


Figure 6. A simple lens can (a) focus a parallel bundle of rays onto a single point, or (b) convert the rays from a single point source into a parallel (collimated) beam of light.

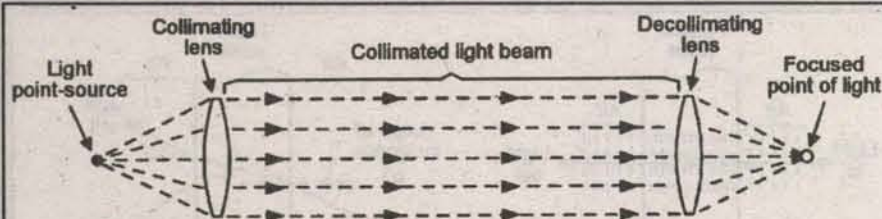


Figure 7. Basic way of using two lenses in a light-beam system.

shows the effects that the prisms have on a light ray that arrives at an incident angle of zero degrees. In both cases, the ray passes

cleanly through the glass without bending but, on leaving the glass, the ray bends away from the normal by about 15°, thus obeying

the basic Laws of Refraction.

Note in Figure 3 that the degree of ray bending is independent of the thickness of the prism glass and (ignoring n value effects) is determined mainly by the angle of incidence of the ray and by the angular difference between the prism's input and output surfaces.

Regarding the ' n value effects' mentioned in the above paragraph, it is important to note that the refractive index values of all transparent media other than free space vary with the wavelength of a light, and increase as wavelength shortens. The refractive index of glass is normally measured using a yellow sodium light with a wavelength of 589nm; the actual index value is higher than normal to violet light (400nm wavelength) and lower to red light (700nm wavelength).

Figure 4 shows, in exaggerated form, the results of passing a narrow beam of white light through a symmetrical triangular prism. White light contains all the colors (wavelengths) of the

visible spectrum, and the prism thus (because its refractive index is wavelength-dependent) bends each individual color of the beam by a different amount, giving the least bend to red light and the greatest bend to violet light. The prism's output thus takes the form of a vertically-expanded colored spectrum. This scatter-

ing of white light's component colors is known as *dispersion*.

When a ray of light passes through air and enters a prism, it bends by an amount determined by its angle of incidence and by the refractive index value of the glass. When the ray leaves the prism again and returns to the air, it bends by an amount determined by its angle of incidence and by the refractive index of the air (1.0) divided by that of the glass (say 1.5), and this value is invariably less than zero (0.667 in this example). Figure 5 shows the actual amounts of output refraction that occur on three different prisms that each have a refractive index of 1.5.

In Figure 5, the ray strikes the output surface of prism A at an incident angle of 30° and leaves the prism at a refractive angle of 42°; this prism thus bends the ray downwards by 12°. In the case of prism B, the ray strikes its output surface at an incident angle of 40° and leaves at a refractive angle of 85°, thus bending the ray downwards by 45°.

Note in the case of prism B that the ray leaves the prism at an angle that is only 5° less than the angle of slope of the prism's output face, and it is obvious that if the angle of incidence is increased much more, the ray will be unable to penetrate the prism's output surface. The angle of incidence at which this occurs is known as the surface's *critical angle*, and is dictated by the n value of the glass; the critical angle is 43° at an n value of 1.5, 36° at an n value of 1.7, and 32° at an n value of 1.9.

Figure 5 shows, in the Prism C diagram, what happens to the light rays when they strike the prism's output face at an incident angle of 45°, i.e., at an angle greater than the critical angle of the surface. Under this condition, a phenomenon known as *total internal reflection* occurs and makes the internal surface act like a mirror that bends the rays by double their angle of incidence, thus (in this case) bending them through a 90° angle and projecting them through the lower face of the prism.

The internally-reflecting type-C prism thus acts like a mirror that bends light through 90°, but (since the light passes through separate

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input and output surfaces) does not suffer from parallax errors. This type of prism is widely used in high quality optical instruments and devices such as reflex cameras, binoculars, and automatic laser-aiming controllers.

Total internal reflection can occur whenever one transparent material interfaces with another that has a lower refractive index, thus giving a less-than unity refractive index and a positive critical angle value at the interface junction. All modern fiber optic cables rely on this 'internal reflection' basic principle for their very efficient low-loss operation (fiber optic cable principles will be described in Part 3 of this series).

LENSES

Normal optical lenses are light-bending refractive devices that are related to prisms but have curved (rather than flat) faces. Figure 6 shows the classic profile of a simple lens that has two parallel faces that are each radially curved in two dimensions, to form a section of a sphere. This type of lens can focus a parallel bundle of light rays onto a single point (the focal point), as shown in Figure 6(a); the distance between the center of the lens and the focal point is the focal length of the lens.

If a light point-source is spaced from the lens by a distance equal to the focal length of this type of lens, the lens converts the light into a parallel ('collimated') beam of light, as shown in Figure 6(b).

Figure 7 shows the basic way of using two simple lenses in a light-beam alarm or communication system. At one end of the system, the left-hand lens converts the transmitter's light point-source into a collimated (parallel) light beam and, at the other end of the system, the right-hand lens converts the collimated beam back into a point of light, which is applied to the receiver's light-sensitive input. Identical lenses are used in the collimating and decollimating processes.

Systems of the above type only generate a perfectly parallel beam if the light point-source is infinitely small, and this is an impossibility. In practice, the beam widens with distances after leaving the collimating lens; the amount of widening is proportional to the width of the light source and inversely proportional to the diameter of the lens. For minimum widening, the lens diameter must be large relative to that of the source.

Simple lenses with one or both faces shaped as a section of a

sphere are known as *spherical lenses* and are available in *convergent* and *divergent* types; convergent types make a parallel beam of light converge towards a common focal point; divergent types make a parallel beam of light diverge outwards. Figures 8 and 9 show a variety of lenses of these types.

Figure 8 shows four simple types of convergent spherical

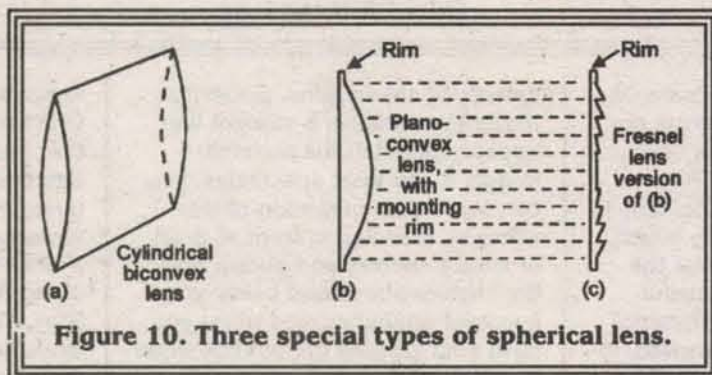


Figure 10. Three special types of spherical lens.

lens. The thin biconvex lens shown in (a) is the same type as shown in Figure 6; it operates equally well either way around, but its sharp edges are rather fragile. The thick biconvex type shown in (b) gives the same performance as the (a) type, but is more rugged.

The plano-convex type shown in (c) has one flat and one curved face and must be used the correct way around, with the flat face pointing in the direction of the parallel light beam and the curved face aimed towards the light's focal point. The convex meniscus type shown in (d) has a very long focal length; it

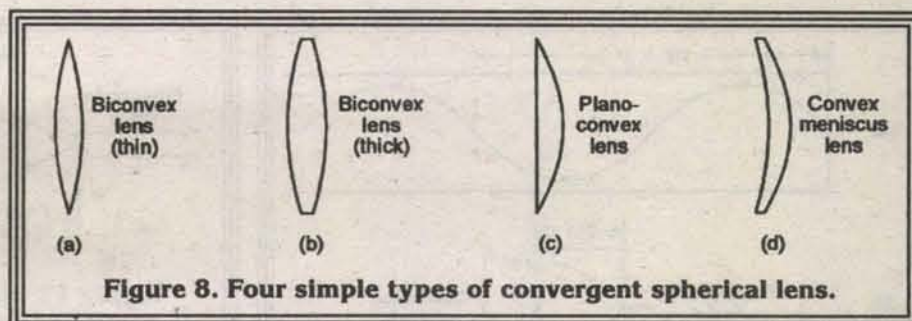


Figure 8. Four simple types of convergent spherical lens.

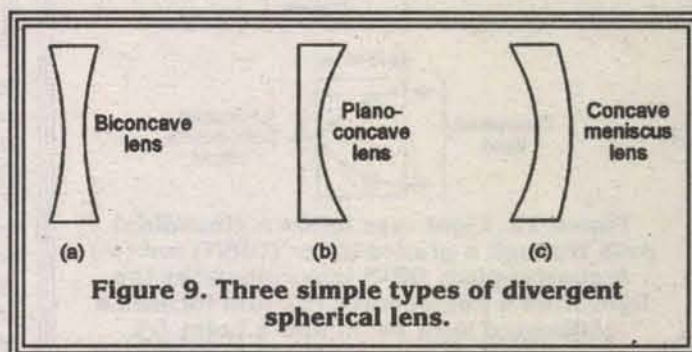


Figure 9. Three simple types of divergent spherical lens.

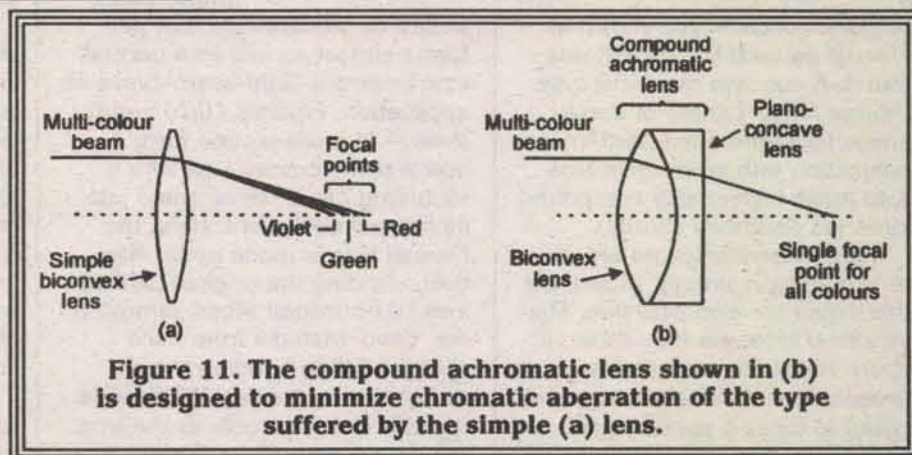


Figure 11. The compound achromatic lens shown in (b) is designed to minimize chromatic aberration of the type suffered by the simple (a) lens.

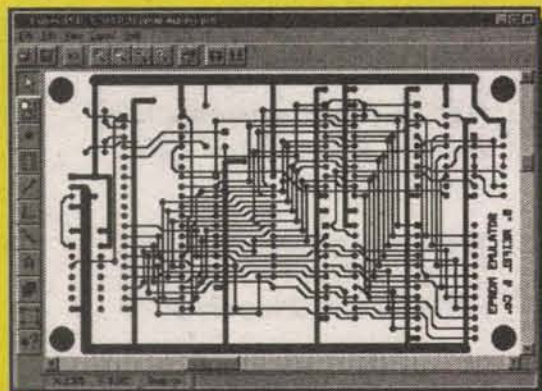
is the type used in most spectacles and contact lenses.

Figure 9 shows three simple

types of divergent spherical lens. The biconcave lens shown in (a) can be used either way around, but

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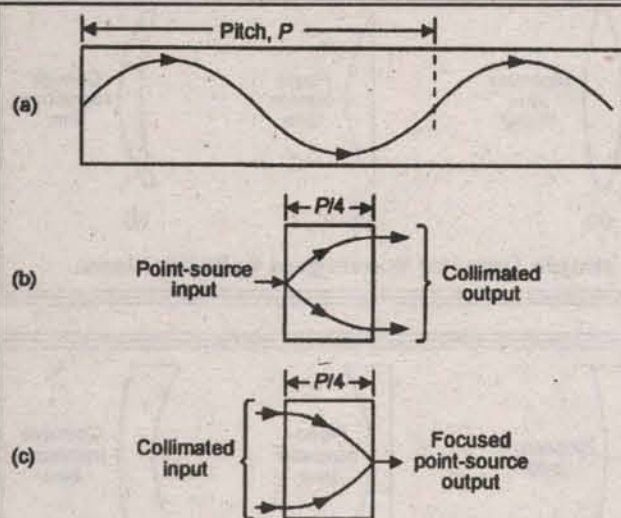


Figure 12. Light rays follow a sinusoidal path through a graded-index (GRIN) rod (a). A quarter-pitch GRIN lens collimates the light from a point-source (b), and focuses a collimated light beam into a point (c).

the plano-concave type shown in (b) must be used the correct way around. A concave meniscus type is shown in (c). Lenses of these various types are often used in conjunction with convergent lenses, to make high-quality compound lenses (as described shortly).

Most spherical lenses are of the simple type already shown, but other types are also available. The cylindrical biconvex lens shown in Figure 10(a), for example, is curved in one dimension only, and is used to focus a parallel light beam into a thin line, rather than a spot, or to convert a thin line of light into a collimated beam.

In most normal lenses, much of the sub-surface glass or plastic

weight or low-cost lens that performs almost as well as a normal lens in simple 'light-beam' types of application. Figures 10(b) and (c) show — in cross-section form — how a plano-convex lens with a mounting rim is transformed into its Fresnel equivalent. Here, the Fresnel lens is made up by effectively dividing the original (b) lens into 10 horizontal slices, removing the 'dead' material from each slice, and then bonding the remainder onto a base of identical material that also acts as the lens rim. In practice, most Fresnel lenses are molded, in plastic or glass.

The focused images generated by simple spherical lenses suffer from spherical and chromatic

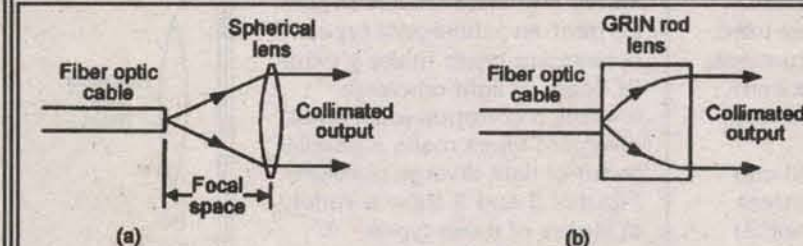


Figure 13. Method of collimating the light output from a fiber optic cable using (a) a spherical lens and (b) a GRIN rod lens.

lens material performs no useful function. A Fresnel lens is one in which most of the non-useful lens material is removed, to make a light-

defects or aberrations. *Spherical aberration* makes a straight line appear curved in the focused image; if you wear spectacles, you can see a demonstration of this effect by standing in front of a set of library shelves and noting how the shelves above and below your eye level appear curved when you have your glasses on, but not when they are off.

In simple lenses, *chromatic aberration* makes faint colored fringes appear around focused white or multi-colored images. The effect occurs because the refractive index of the lens material (and thus the focal length of the lens) varies with the color of light, as shown in Figure 11(a), making it possible to sharply focus only a small slice of the color spectrum; the rest of the spectrum is out of focus, producing the 'fringe' effect.

This problem can be overcome by using a compound lens made of one converging and one diverging lens, each with a different refractive index value, as shown in Figure 11(b). Such a lens can be made to give all colors

the same overall focal length, and is known as an *achromatic* or *antispectroscopic* lens.

The strangest and most recently developed lens is the *graded-index* (GRIN) rod lens, which is used in modern fiber optic applications and operates in a dif-

ferent way to a normal lens. A GRIN rod is a glass or fiber rod that has a refractive index that decreases progressively with distance from the rod axis. This index variation causes light rays to follow a sinusoidal path as they travel along the rod, as shown in Figure 9(a). The length of one complete sinusoidal cycle in the rod is called the *pitch* (P) of the rod; the P value is determined mainly by the rod's diameter and refractive index profile; the value is typically about 20mm.

A GRIN rod lens is simply a slice of GRIN rod with a length less than a single pitch-length, so that its optical output signal is out of phase with the optical input signal. The most interesting and widely used GRIN rod lens has a quarter pitch (giving it a length of about 5mm) and has the interesting properties illustrated in Figures 12(b) and (c).

Note in (b) that the light from a point source in contact with the center of the left face of the lens emerges from the right face in fully collimated form and, in (c), that a collimated light beam entering the left face leaves the right face as a focused spot. The GRIN rod lens thus has some properties of a conventional lens, but has a very short focal length.

GRIN rod lenses are widely used in modern fiber optic and laser module applications. Figure 13 shows an example that illustrates the advantages of a GRIN rod lens over a spherical lens in a simple fiber optic application in which the fiber optic cable's point-source 'light' output needs to be collimated when fed into the outside world.

In the case shown in (a), the light is collimated by a conventional lens, which must be placed a precise fixed distance from the end of the cable, to which it is coupled by an air gap. In the case shown in (b), the GRIN rod lens is simply bonded directly to the polished end of the cable, and no carefully spaced air gap is required.

More information on fiber optic and GRIN (graded index) operating principles will be given in next month's episode of this series, which will give an in-depth explanation of fiber optic principles and practice. **NV**

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From a teaching tool that moves continents to an electronic pop-top opener, from a laptop security gadget to a color reader for the blind, from a new fire-fighting safety tool to an outdoor strobe thermometer, the bright ideas of six students were rewarded with first and second place honors in the 1999 Duracell/NSTA Scholarship Competition.

Duracell and the National Science Teachers Association announced first through fifth place winners who were recipients of \$160,000 in savings bonds during the 17th annual competition.

Over 1,900 students submitted photos and plans for 1,432 prototype entries in the 1999 Duracell; 100 were selected as finalists. These finalists were awarded savings bonds ranging in value from \$20,000.00 to \$500.00. The six first and second place winners, accompanied by their sponsoring teachers and parents, were honored in Boston March 24 and 25 during the annual convention of the National Science Teachers Association (NSTA).



FIRST PLACE WINNERS

First place winner in the 10th through 12th grade category was **Tom Kennedy**, 17, a senior at Randolph High School and a resident of Randolph, NJ. He received a \$20,000.00 savings bond for the **Cojack Laptop Computer Anti-Theft System**.

Cojack is a small, convenient anti-theft system. Its design could also be applied to protecting other valuables such as golf clubs, musical instruments, and portable stereos. An important feature is that it turns itself on so the owner does not need to remember to arm it. Kennedy's sponsoring teacher is George Collett.

The first place \$20,000.00 savings bond winner in the 6th through 9th grade category was **Ilana Jaatmaa**, 13, an 8th grader at Walkersville Middle School who lives in Frederick, MD. Jaatmaa's battery-operated invention is **Pangaea, A World in Motion** — a moving map and educational tool for children.

A World in Motion shows the changes of Earth's continents, from how they are today to a single large landmass, as Earth was 170 million years ago. "During this project, I learned a lot about gear ratios, levers, and serial electrical circuits in addition to continental drift," Jaatmaa says. Her sponsoring teacher is Owen Davis.

Sponsored by Duracell, Inc., and administered by the National Science Teachers Association, the Duracell/NSTA Scholarship Competition has awarded over \$990,000.00 in scholarships, savings bonds, and cash awards to over 875 students since 1983. Student inventors retain all rights to their devices.

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54201D, Digitizing Oscilloscope	\$2650
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8350B, Sweep Oscillator Mainframe	\$1500
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8494H, Programmable Attenuator (unused)	\$800
8495H, Programmable Attenuator (unused)	\$600
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8566A/B, Spectrum Analyzer, 100Hz-22GHz	\$17,000
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466, 100MHz Storage Oscilloscope w/DMM4	\$800
475, 200MHz Oscilloscope	\$650
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CG5001, Programmable Calibration Generator	\$4000
DSA602, Digitizing Signal Analyzer	\$7500
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MISCELLANEOUS

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California Inst. 4503L, AC Power Source	\$4000
Datron 1061A, 6.5 Digit Autocal Multimeter, DC Only	\$700
Datron 1062, 6.5 Digit Autocal Multimeter, DC/AC/Ohms	\$900
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EIP 548A, Frequency Counter, 10Hz-26.5GHz	\$2000
EIP 548B, Frequency Counter, 10Hz-26.5GHz	\$3250
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Fluke 5200A, AC Voltage Calibrator	\$2000
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Fluke 8012A, Digital Multimeter	\$175
Fluke 8050A, Digital Multimeter	\$250
Fluke 8502A, Digital Multimeter, DC Only	\$225
Fluke 8520A, Digital Multimeter	\$350
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Fluke 8810A, Digital Multimeter	\$250
Gigatronix 910, Frequency Syn., .05-26GHz	\$7000
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Kikusui PAB18-1, DC Power Supply, 18V/1A	\$100
Kikusui PAB18-3, DC Power Supply, 18V/3A	\$125
Kikusui PAB18-3A, DC Power Supply, 18V/3A	\$145
Kikusui PAB32-2A, DC Power Supply, 32V/2A	\$175
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Krohn-Hite 3202/R3202, Tunable Filter/Rack Version	\$500/\$350
LeCroy 9424, 350MHz Oscilloscope	\$3500
Marconi 2019A, Signal Gen., 80KHz-1040MHz	\$2200
Polarad 1105E-F, Signal Generator, 0.8-2.4GHz	\$400
Sorensen DCS40-25, DC Power Supply, 40V/25A	\$750
Trans. Devices DLR400 15 3500A, Dynamic Load	\$1500
Trans. Devices DLP 50-60-1000A, Electronic Load	\$800
Trans. Devices DLVP 130-110-1000 Electronic Load	\$950
Trans. Devices DLVP 50-120-1000 Electronic Load	\$1000
Valhalla 2703, AC Voltage Standard	\$2350
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W & G SNA5, 50Hz-3.2GHz Spectrum Analyzer	\$5000
Wavetek 178, Automatic Synthesizer	\$1850
Wavetek 650, Precision 2MHz Variable Phase Synthesizer	\$1700
Wavetek 2001A, Sweep Generator, 1-1400MHz	\$450
Wavetek 3000-200, Signal Generator	\$900
Wavetek 8003, Precision Scalar Analyzer, 10MHz-40GHz	\$2000
Wavetek 8501, Peak Power Meter	\$2000
Wiltron 560-7550, RF Detector, 10MHz-18.5GHz	\$300
Wiltron 560-7550, RF Detector, 10MHz-26.5GHz, Opt. 2	\$400
Wiltron 560-97N50, SWR Autotester, 10MHz-18GHz	\$600
Wiltron 560-97S50, SWR Autotester, 10MHz-18GHz	\$600
Wiltron 561, Scalar Network Analyzer	\$2500



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350MHz, TEKTRONIX 485,

A superior performing O'scope, Dual Trace, Delayed sweep 1 nS/div Sweep rate, 5mV Vert. sensitivity. Switchable input imped., 50 ohm /1meg. Package includes 2 probes, cover and operation manual. Six month warranty. Excellent condition. **ORIG., \$9100ea.**

SPECIAL.....\$795

ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAMERA

Sleek black anodized, alum. housing, O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mm d. x 50mm, 36" cable with BNC video & DC barrel jack. **GM-200K-STD.....\$119**
PINHOLE Model. So tiny you can install it directly into a door. Only a 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2 ounce! Size only 23mm d. x 35mm long. Think of the places you could put this little jewel. **GM-200K-PH lens.....\$119**

NEW! 0.008lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE. Our GMV-2K, DOES it in COLOR TOO!

For covert, military and scientific applications that must be color, this is it. Performance is enhanced through low speed electronic shuttering and digital frame memory. With an auto iris lens, 24 hour monitoring is possible. Auto sensitivity mode starts as it becomes dark. Eight Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64, X128. These provide frame rates of 60, 15, 8, 4, 3, 2, 1, and 0.5 frames per second. Auto/Manual white balance. Aluminum housing with dual 1/4x20 mounts. Specs: 1/3" CCD, with 291K pixels, 320 Lines, <1 Lux std. mode sens., 12VDC @200mA, Std. video out on BNC. Size: 54mmx50mmx94mm long. With pwr. adapter. All functions can be externally controlled via an 8 pin mini DIN. Uses std. c-mount lens not included.

Special Item, GMV2K.....\$589ea.

4mm, f1.4 A/I lens with custom cable.....\$99ea.

**Please fax us your list of
unique surplus material.**

NEW! DAYLIGHT to LOW LIGHT MINI CAM, w A/I LENS

For those applications that must work from dawn 'till dusk, this is it. Rugged aluminum housing with dual mounting sockets. Specs: 1/3" CCD, 420 lines resolution, 0.1 Lux sens., AGC, Auto shutter. 12VDC @120mA. Take full advantage of camera sensitivity with the super, 4mm, f1.4, 78° FOV Auto Iris lens included. Video out on BNC. Size: 50mm sq. X 65mm long. Power adapter included. Ready to go!

SPECIAL this MONTH, GM-510-A/I.....\$199ea. or 2 for \$369

CHECK THIS! ULTRA MINI, WEATHERPROOF & COLOR!

NEW "COLOR LIPSTICK" camera. For those applications that must be color, this is it. Black anodized, aluminum, housing is O-Ring sealed & RAINPROOF. Adjustable tilting mount included. Specs: 1/3" CCD, 400 Lines resolution, <1 Lux sensitivity, AGC, Auto Shutter. 12VDC @180mA, 4.3mm, 78° FOV lens, A real glass lens. Std. video out. Size: 32mm diam. X 65mm long. 24" leads with RCA jack and DC jack. With pwr. adapter. Ready to go!

SPECIAL this MONTH, GM-400K.....\$239ea.

NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN' GO UNDERWATER (down to 60 ft.)

Waterproof B&W CAMERA with INTERNAL, INFRARED ILLUMINATOR!

Sleek black anodized, BRASS, housing is O-Ring sealed & WATERPROOF. Adjustable mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25" diam. X 2" long. With 60 ft. cable. Great for general outdoor use also. **REG. \$299, GM-300KIR.....\$219**

DOVER AIR BEARING X/Y TABLES, ULTRA PRECISE,

Like New, The ultimate in precision motion control. These are leadscrew operated air bearing tables with 1-20 Microns typical repeatability. Straightness, less than 1 micron each axis, angular error, less than 1 arc/sec. Squareness, less than 5 arc/sec. Three models available. Model "A" has 6"x6" travel with 2 type 238LS-021-02, 4.85A 24V Rapidsyn stepper/encoders. Type "B" is as above without motors. Type "C" has 4"x5" travel with two Compumotor LE57-51-MTR steppers. No controllers. **TYPE "A".....\$1200, TYPE "B".....\$949, TYPE "C".....\$849**

TINY, PRECISE, PORTESCAP SWISS, GEARMOTORS.

State of the art "Ironless" type, mini motors. Mod. A (left): 1219E-012-G-400 has 1044:1 Planetary gearbox. Size: 12mm d. x 44mm L. Model B (right): M11-210-54-0 with approx. 40:1 spur gearbox. Size: 16mm d. x 43mm L. Both have 2mm d. x 6mm L. flatted shaft, solder terminals.

VIN INL RPM

A: 6V 5mA 68

12V 5mA 145

B: 6V 8mA 141

12V 12mA 290

LIMITED QUANTITY

TYPE A: \$19ea. or 2 for \$34

TYPE B: \$15ea. or 2 for \$27

PIEZO ELECTRIC, 2-AXIS, TRANSLATOR

Physik Instrumente, P267 Like New, The ultimate in precision motion control. Includes two P178.37, 1/2" diameter PZT mounts. Each providing up to 40 microns of ultra precise movement. Motion can be controlled from the front panel or via an external control voltage. Rack mountable. **SPECIAL.....\$849**

COMPUMOTOR SX series, MOTION CONTROL

The SX is a bipolar, microstepping drive with built-in indexing. Drives two-phase permanent magnet step motors. MOSFET technology gives high performance in a small package while providing protection against short-circuit, brownout and over-temp. Built-in power supply. Indexer can store 99 multiple move motion programs in battery backed RAM. Programs can be selected via BCD inputs, programmable controllers or a computer via RS-232C Interface. The SX also provides the following features:

- 16 selectable resolutions (200 - 50,800 steps/rev)
- Smooth microprocessor controlled, wide range microstepping.
- Closed-loop positioning interfaces to incremental or absolute encoder.
- Motion profiling allows distance based velocity change without stopping.
- 90VAC - 132VAC, 50/60Hz power input. MANY more features too numerous to include here. Used, excellent condition. User manual.

SX model \$199 or 2 for \$349 also S model \$189 or 2 for \$329

TEKTRONIX 2465ADM, 4 Channels and 300MHz, O'Scope

on screen waveform

stats, DMM readout.

One of the most popular & powerful scopes available at a reasonable cost. Features: 500ps/Div sweep, 2mV/Div. vertical sensitivity, 1Mohm / 50-ohm input, 500MHz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Plus complete DMM! Complete with 2 probes, pouch, and manual. Mint condition, 90 day warranty. **\$2695.**

END FIELD of VIEW GUESSWORK!

3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97° FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard C-Mount with adjustable focus and iris. **SPECIAL.....\$99ea. or 2 for \$189**

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NEW, "STEALTH CAM", MICRO, with AUDIO!

The sleek aluminum housing fits like a glove! Removeable mounting bracket and a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC barrel jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM". 1/3" CCD, 410 Lines, 0.3 Lux, AGC, Auto Shutter. Pwr. from 9 to 12VDC @110mA, 250K pixels, Std. model, 4mm, 78° FOV lens, Pinhole model, 90° FOV. A real glass lens. Focus from 10mm to infinity. NTSC video out. Only 1.7 ounce! SENSITIVE to IR. Size Std: 30mm sq. x 29mm d. PH is 16mm d. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS.

GM-2000S-STD, w/aud.\$79.00

GM-2000S-PH, w/aud.\$79.00

VICTOREEN 10,000Volt, 100Megohm Resistor!

A must have for serious high voltage work. New, non inductive, 5% tol., low tempco. Mini size only: 1" x .27" x .06" Hard to find. **10 for \$6 or 50/\$24**

**SLIM MOX
104 100M 5%**

Brand New, Video Motion Sensor. Model VM10. Attach

to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Use it to turn on a VCR or call the hounds. Auto or manual reset. Compact, ac powered. Adjustable sensitivity. Video loop through jack. **NEW VM-10.....\$189.**

Low cost MICRO CAMERA, w/audio

1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250K PIXELS, Std. model, 4mm, 78° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size Std: 1.25" sq. x 1" d. PH is 0.6" d. 1.6M long wiring harness with connectors included. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS. Six different models.

GM-1000A-STD.....\$60 GM-1000A-STD/Aud.....\$65

GM-1000A-PH.....\$60 GM-1000A-PH/Aud.....\$65

GM-1000A-CMNT.....\$60 GM-1000A-CMNT/Aud.....\$65

Micro Lenses for GM1000 series

2.5mm, 150°.....\$22 8.0mm, f2.0.....\$22
4.3mm, 78° f1.8.....\$22 12.0mm, f2.0.....\$22
6.0mm, f2.0.....\$22 5mm, 70°PH.....\$22

C-MOUNT LENSES

LOW LIGHT 16mm, f1.6, 15° FOV.....\$39 4mm, 80° FOV.....\$24
8mm, f1.3, 40° FOV.....\$49 8mm, 40° FOV.....\$24
4mm, f1.4, 78° FOV.....\$49 12mm, 28° FOV.....\$24

6V@12AH SEALED, RECHARGEABLE, BATTERY

New Panasonic, LCR6V12PI. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D **2 for \$20, or 10 for \$89**

NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER with SONY, CCM-PC5 COLOR CAMERA.

Originally sold for \$500! Now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic, providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens. (1" to infinity, macro capable) Auto power off when the privacy shutter is closed. Power is 7-13VDC. (all pwr. adapters and cables included) 1/3" CCD, 330Lines res. 35% better than standard VHS! Can also be used to transmit VCR output to another TV for remote viewing.

SPECIAL, 2.4GHz SONY-ASTROVIEW.....\$189ea. or 2 for \$339

addtl. 2.4GHz TRANSMITTER/RCVR. less Camera...\$129ea.

MOTORIZED ZOOM LENS SPECIAL, 6X mag. and auto iris!

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from \$600 to \$1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. The Auto Iris has a built in amp which works with any cameras video output for control.

Type B-6, 12.5 to 75mm, 6X, f1.2 \$189 or 2 for \$349

ZOOM LENS CONTROLLER, NEW \$169

10V @ 2.5 AH SEALED, LEAD ACID, PACK

Each pack consists of five, 2 Volt cells. Each cell the size of a std. 'D' battery. They are arranged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Mint condition. Perfect for robotics and other high drain applications. Buy several, make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D **5-five packs for \$20, 30 for \$99**

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

I would like to build an adjustable thermal switch circuit to turn a 120-volt fan on/off. The circuit will be used with my home stereo receiver to turn on/off at set temperature of receiver temperature. The thermal sensor will be located on the outside of the receiver cabinet.

The fan is 120 volts and impedance protected. The circuit could also be used to operate a brushless 12-volt DC fan as well.

4991 Brad King
Winter Haven, FL

I am the proud owner of a military surplus PU-286 generator. The machine was made in 1958. While the generator is in fairly good shape, it could stand an overhaul.

Where can I obtain repair parts for the engine and the alternator. Operating supplies such as oil filters and exciter brushes are also needed.

4992 Bob Feeney
Atlanta, GA

I have a 1 MHz oscillator. Can anyone come up with a circuit that will provide outputs at 100 KC, 200 KC, and 500 KC.

I have 7490 and 4017 ICs on hand. The 1 MHz output is about 4-1/2 V PTP squarewave.

4993 Roger W. Hamel
Cedarville, MI

I have a Caller ID compatible modem that I would like to read the Caller ID information from the modem with Visual Basic 4.0 or 5.0.

Any suggestions on where to begin?

4994 Dan Hockey
via Internet

At my office we have a problem with telephone extensions ringing in adjacent cubicals causing confusion with exactly who's extension is ringing. If you are standing more than a few feet away from your phone, you never know if it's your phone or not.

Is there some type of visual indicator (preferably LED) that can detect a ring and flash? This device must not be electrically connected to the phone system, i.e., it must use the sound of the ring or something of that nature to do its ring detection.

The type of phone we use is the

Lucent Technologies 825 (nice phone — lousy ringer).

I work at a government agency, and I cannot connect anything to the phone. I would like to run this up to the top of the cubical to give me a visual queue to my ringing extension.

4995 R. S.
Baton Rouge, LA

In regards to the Alphastar satellite system: Is there a way to change the S/R (symbol rate, Astar's is 23.000) and the FEC (freq. error correction, Astar's is 2/3) to a different setting that would allow one to use this receiver to view MPEG 1 or 2 digital? This system was manufactured by Tee-Comm, Inc.

Would this be a firmware change/mod?

4996 Chief
via Internet

I am looking for an inexpensive way for a young ham operator to build a direct conversion receiver to listen to W/AW, either 80 or 40 meter.

This receiver should be where we could wind coils on a photo container. All the parts should be available at RadioShack.

4997 Virgil Gochee
Shabbona, IL

In cannibalizing a computer, I thought I had a good power supply (Power Tronic TK 4230DC). However, it trips off in less than one second, perhaps because one output (the "power good") is unused.

How do I hook up the "power good" lead so that the power supply will operate?

4998 Scott Duink
Los Gatos, CA

I have two UPS with similar problems. They both work except they shut down after they switch and start generating their own power.

They act as if the battery is low, but they are both good (fully charged). One will operate fine on low-line voltage, but shuts off when the line voltage goes below about 50 volts. The other shuts off after 0.1 to 2 seconds after power loss and also works on low-line voltage.

One is an ABI International

model Probackup 5000, the other is a Deltac model PRB 300. Why are they so complicated to do a relatively simple job?

4999 Gordon Simkin
Bellevue, FL

I need to locate a product that was made years ago in Sharon, PA. The name was "SAL-MET FLUX" solders all metals. It was a soldering flux that you could use with regular solder and you could solder aluminum, stainless, etc.

The company was a small operation, Hascol Enterprises and then sold to Henry Manufacturing in Westville, IL and now I cannot find any information on it.

49910 Ron Wineland
Meadville, PA

I understand that the military has been using a "cigarette pack size" electronic device to remove sulfation from car batteries, with up to five times the original lifespan of the batteries. I am looking for the circuit.

49911 Paul Isvolt, Jr.
Brantwood, WI

My VCR has channel 3 and 4 output. I would like to feed this into something that I can build or modify to have channel 3 or 4 in (one or the other not both), with channel 2 out, and have adjustable fine-tuning, and pass stereo audio.

49912 Lane Dixon
Haysville, KS

How do I interpret the error codes that pop up on the screen when a computer boots up with a problem? (Example: Screen reads bad fault in MS DOS extender).

49913 Larry Amati
Smithton, PA

I have several old King two-way radios: model LPA 5141 FCC ID ASY7BL LT 2001 made in Lawrence, KS.

The units have a rotary switch providing up to 14 different frequencies. Some are set from 144 to 163 MHz and some are blank, but make a squelching noise when squeezing the transmit button.

Where can I get a schematic or find someone who is familiar with

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
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- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

these radios, and how can one change frequency settings?

How much power are they putting out with a fully charged 10-volt battery? What distance can I reach?

49914 Pierre Hoyt
W. Bethesda, MD

I have an old IBM 3270 PC, model 16 with 640 KB, 5-1/4 disk drive that uses double density, double sided floppies.

Since I have no need of the newer, faster PCs on the market, I

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TECH FORUM

am reluctant to go out and buy a new PC.

My problem is that I would like to use several software programs that are on 3.5" 144 KB disks.

Would it be possible to add a 3.5" disk drive to this unit? What would I need in the way of hardware if it can be done?

**49915 Pete Bartholomey
Chattanooga, TN**

I need a solution to interface TV audio output to a strip of 10-20 headset jacks used in a dorm environment day room as a noise preventive. On the newer TVs, the output device overloads.

**49916 D. B.
Lansing, KS**

I hope to construct a series (61 total) of very narrowly selective band-pass filters (ideal less than 2% BW) to be used with live and recorded outputs of music synthesizers.

The outputs of these filters, rectified and likely buffered, would be used to selectively 'gate' the outputs of 61 selectively 'tuned' gravity-wave (per Gregory Hodowanec's work) sensor-oscillators.

With so many (61) filters needed, simplicity of construction and lowest costs are a prime consideration. Also, for the sake of flexibility and portability, this 'filter bank' should not be computer technique dependent.

**49917 Bill Ramsay
Grand Junction, CO**

I have a GBC look-out video camera, model LC2001. I need the pin out of the plug on the camera or a schematic.

**49918 Frank Bowen
Fresno, CA**

I drive a turbo diesel and the engine compartment suffers from very high temperatures in the summer. This has resulted in several premature failures of my alternator mounted voltage regulator (cracked).

Can you provide a design utilizing heatsinks and high-quality components so I can build and remote mount a regulator?

The regulator now on the alternator is about 3/4" square, and 1/4" thick with three connections: one to ground, one each to two brushes. I will modify the brush plate and provide connectors.

**49919 Roger Simon
Orlando, FL**

ANSWERS

ANSWER TO #3997 - MAR. 1999

Whenever you get a "Blue Screen of Death" (BSOD) in Windows, it means that a program did something bad, usually trying to access an illegal memory address or

performing an illegal function (i.e., divide by zero). Since you didn't give any more detailed information, I can only assume that one or more software modules used by Explorer is corrupted.

Question: Does the BSOD happen with any other program either before or after you use Explorer? If so, that program might be the culprit. Reinstall it and see if that fixes

the problem.

Next, I suggest you disable any/all programs you loaded at boot-up (i.e., "empty" the "Startup" folder) and see if Explorer still gives the BSOD. If it does, then you need to "refresh" the Explorer software by running SETUP on your Windows install CD/floppy and choosing "Restore damaged/missing pro-

Continued on page 54

ANSWER TO #39910 - MAR. 1999

A friend of mine bought a Spectracom WWVB VLF receiver/comparator without its active antenna. The manual didn't provide any schematics for the antenna, but the receiver input section supplied 12 VDC through a few kilohms and wanted a 50-ohm AC input.

We found many WWVB antenna designs on the web, but the designs did not meet the 50-ohm requirement or had other problems, so we built our own antennas.

The first was a ferrite loopstick 0.5 x 3 inches that had trouble locking [WWVB signal strength is about 100 microvolts per meter here]. The second was a small loop antenna of an 8 inch diameter, and it worked okay. The third was a 20 inch diameter loop that produced a signal big enough that I could see it on my [very sensitive] scope, but it was never connected to the Spectracom.

The output transformer has a tap with a 1:7 turns ratio. That raises the 50-ohm load impedance to about 2500 ohms. For a Q of about 100, the transformer reactance should be 25 ohms ($X_L = 2 \pi f L$, or $L = 25 / (2 \pi f) = 66$ microhenries). I used an MPP toroid (Arnold A051027) at 27nH/square turn, so $N = \sqrt{66 \mu H / 27 nH} = 49$ turns. I put the tap at seven turns.

If you use a different core, then calculate the proper number of turns and make sure the core has reasonably low loss at 60 KHz. Use thick wire to improve the Q. The resonant capacitor is $C = 1 / (L (2 \pi f)^2) = 106 nF$, but the value is not exact and must be tuned. I used a signal generator (with the loop antenna disconnected) and two paralleled capacitors to tune the output tank.

Use a large capacitor to get close and then use a smaller capacitor to fine tune the tank. You can also adjust the number of turns, but one turn changes the inductance by about four percent. You must tune to 0.5 percent or better.

Wind the 20 inch antenna loop as 11 turns of number 12 solid insulated wire (the kind electricians use); that's about 60 feet of wire. I taped the wire in a few spots so it would keep its shape. This loop must also be tuned, so I inductively coupled the signal generator to the loop and adjusted the input capacitors to maximize the response. I needed about 60nF ($X_C = 44$ ohms), but your results will vary because a scramble wound antenna loop is not well characterized. The loop must be very low impedance, so make solid connections between the loop antenna and the resonating capacitors.

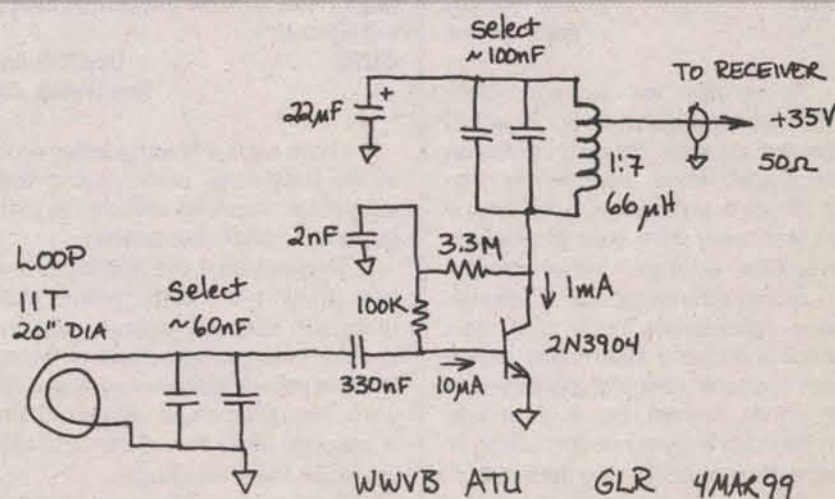
The transistor is targeted for 1mA of collector current. The voltage gain to the collector should be about 80, and the gain to the tap about 11.

The input impedance of the amplifier should be about 3K, and it limits the antenna Q to about 70 (3K/44). You can check the literature for info about adding an electrostatic shield without imposing a shorted turn. We saw a lot of power line impulse noise, but it was magnetic.

Antenna orientation is important. The plane of the loop should be perpendicular to the ground, and the plane should include Fort Collins, CO.

Computer monitors throw out a lot of trash around 60 KHz, so locate the antenna far away from them (and turn them off if you have trouble locking).

**Gerald Roylance
Mountain View, CA**



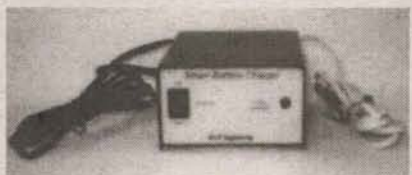
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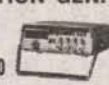
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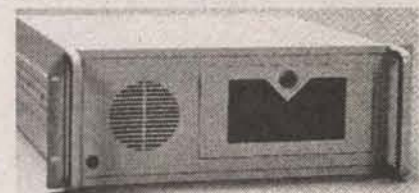
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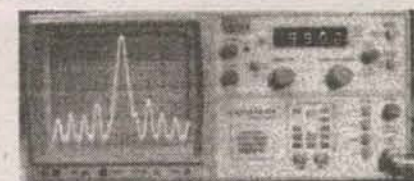
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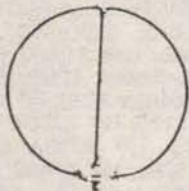
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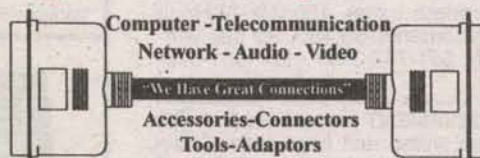
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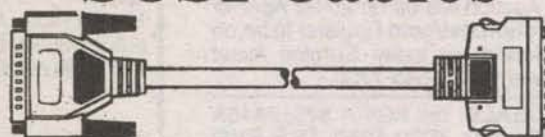
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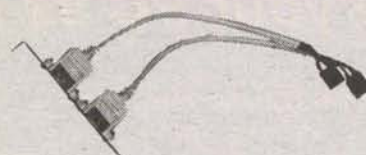


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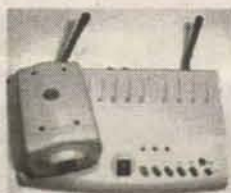
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Treasure Finder Kit



Search for buried treasure at the beach, backyard or park. This professional quality kit can detect metal at a depth of up to 6 inches. Easy to use, just listen for the change in tone as you 'sweep' the unit across the surface - the larger the tone change - the larger the object.

Has built-in speaker or earphone connection, runs on standard 9 volt battery. Complete kit includes handsome case, rugged PVC handle assembly that 'breaks down' for easy transportation and shielded Faraday search coil. Easy one evening assembly. This nifty kit will literally pay for itself! That guy in the picture looks like he found something - what do you think it is - gold, silver, Rogaine, Viagra? You'll have fun with this kit.

- TF-1, Treasure Finder Kit.....\$39.95

Binocular Special

We came across these nice binoculars in an importers close-out deal. Not some cheap in-line lens jobs, these beauties have roof prisms, a super nice rubber armored housing over light weight aluminum. 10 x 25 power with fully coated optics. Includes lens cleaner cloth, neck lanyard and nice carry case. For extra demanding use in bright sun, choose the EX module with ruby coated Objective lens. First quality at a close-out price! We've seen the exact same units with the 'Bushnell' name on them being sold for \$30 more!

- BNO-1, Binoculars and case.....\$24.95
- BNO-1EX, Ruby Coated Lens Binoculars and case.....\$29.95

Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

- SS-70A, Speech Descrambler/Scrambler Kit.....\$39.95
- CSS, Custom Matching Case and Knob Set.....\$14.95
- SS-70AWT, Fully Wired SS-70A with Case.....\$79.95
- AC12-5, 12 Volt DC Wall Plug Adapter.....\$9.95

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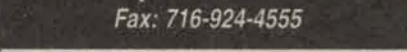
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FAN CONTROLLER

Use this kit to control cooling fans, or any device that is temperature activated. Output is 100mA. For a 3 Amp application use the Relay kit RP-1 or the new Micro-controlled Relay PRC-1 kit. Temperature probe included. Operating voltage: 7.5 to 18v DC. Size: 1.5" x 1.2"

FC-1 KIT \$14.95

WIDE BAND PRE-AMP

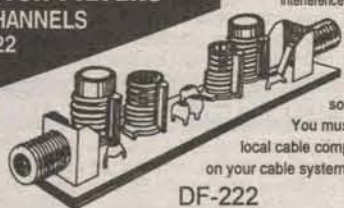
Uses PCB and surface mount technology for better performance. Use this for scanners, HT's, Frequency counters, Satellite Receivers. It amplifies low-level (weak) signals. If the signal is extremely low, two amplifiers can be used in a series.

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- Power requirement: 12v @ 6Ma

WBA-6 KIT \$19.95

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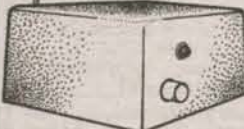


DF-222

KIT \$14.95

FM STEREO TRANSMITTER

Have your own FM radio station. Any stereo signal you plug into the FMST-100 transmitter kit will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Plug in your CD player, tape deck and have a wireless link to any FM radio, within 200 ft. Listen to your CD while mowing the lawn. Transmit from your car to your camper, or through an auditorium. Transmit music on one channel sing on the other. Compatible with any audio system. Clarity is excellent, approx. 40dB stereo separation. Length of antenna determines distance of transmission. Comes complete with left & right input level control as well as a crystal for left & right stereo separation. ANTENNA NOT INCLUDED 9v Battery operation.



FMST-100
Cabinet

SIZE: 1.5" x 1.6" KIT \$29.95
SIZE: 1.5" x 2.5" x 3" \$8.95

RAINBOW MINI-LIGHT Super Bright Flashlight

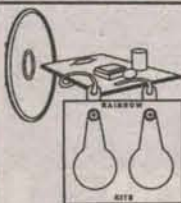
- LED's don't burn out!
- Battery lasts for years!
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- Rechargeable battery!
- Better buy 2, your wife is going to take yours!

Lights up a complete bedroom at night

Red MLR \$9.95 each
Yellow MLY \$9.95 each
Blue MLB \$12.95 each
White MLW \$12.95 each
Infrared MLI \$12.95 each



SHOWN ACTUAL SIZE



LIE DETECTOR

This kit can be great fun at parties. When you lie, generally your hands will sweat and the more you sweat the louder the tone. This kit allows you to measure these changes, only a slight amount of change will cause the tone to increase in frequency. Power requirement 6 to 12v DC. SIZE: .8" x 1.2"

LD-1 KIT \$9.95

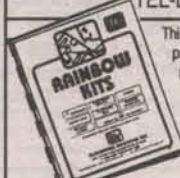


BUSY PHONE LIGHT

Add this little kit to any or all of your telephones. When one phone is used a red LED will light on the other extension.

This lets everyone know when your computer modem is in use. Power requirement 9v DC. SIZE: 1.1" x .6"

TEL-LITE KIT \$9.95



This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

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Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12v DC. SIZE: 1.75" x 1"

AA-1 BUILT \$29.95 KIT \$10.95



STROBE LIGHT

Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC. Size 3.5" x 1.9"

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AUDIO PREAMP

Boost your microphones output up to line level! Plug your mic into our AP-1 and drive your amp, to full capacity. Connect an AP-1 to a pair of amplified speakers, plug your mic in and you have an instant PA system. Requires 6 to 12v DC. Size: 1.75" x 1"

AP-1 KIT \$9.95



Sweet 16
TONE
DECODER

Sweet 16 tone decoder operates great over phone lines, radios or scanners.

- 16 TTL Level Outputs
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- One relay & driver circuit on board.
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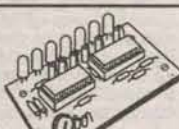
TT-16 KIT \$34.95



WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

WM-2 KIT \$14.95



DC VOLTAGE MONITOR

If battery status is important, you need this kit. This kit uses 7 LEDs to monitor 12v DC in 1v, 1/2v, or 1/4v steps. Monitor 8v or 5v in 1/4v steps. Great for boats, motor homes, model planes or race car ni-cads. All parts and instructions are included. SIZE: 1.3" x 2.7". If you want to switch more power see our Triac (TP-1).

VM-1 KIT \$7.95

For 110 AC VM110 KIT \$10.95



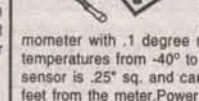
INDUCTANCE METER

This is the kit everyone has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Power requirement 9v DC. SIZE: 1.75" x 2.5"

IA-1 KIT \$14.95



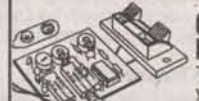
IA-1 CABINET \$8.95



DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt ohm meter into an accurate digital thermometer with .1 degree resolution. Measure temperatures from -40° to 250F° The remote sensor is .25" sq. and can be mounted many feet from the meter. Power requirement 9V DC. SIZE: 2" x 1.35"

DT-3 KIT \$8.95



CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measure capacitors from <2.2pF to 2.2uF. Power requirement 9v DC. SIZE: 1.80" x 2"

CA-1 KIT \$12.95



VOICE ACTIVATED SWITCH

This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm. The VOX-1 kit has 100mA of output that operates a relay, light, motor, ? What could you do with a sound activated switch? Power requirement 7.5 to 18v DC. SIZE: 1.5" x 1.3"

If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.

VOX-1 KIT \$6.95



PHONE RECORDING SWITCH

This phone line powered switch is small enough to be installed anywhere. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use it in your office to record all phone calls so you don't lose important information. SIZE: 1" x .6"

If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.

TEL-SW1 KIT \$12.95



WATER ALARM

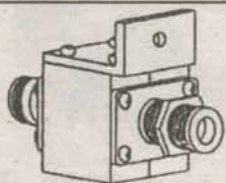
Don't ever get stuck with a flooded basement or over fill your water bucket. When the liquid level reaches the sensor it automatically turns the pump on or off. The Water Alarm supplies you with 100 mA of output that activates a relay (that you supply). This relay can turn on a sump pump, or in applications where you are filling a area with liquid it turns off the pump. Sensor included. Size 1.4" x 2"

WA-2 KIT \$17.95



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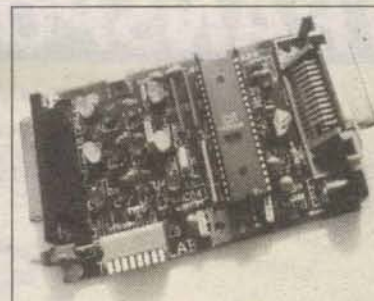
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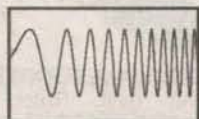
Digital waveforms with adjustable duty cycle



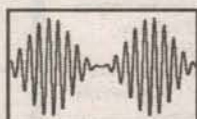
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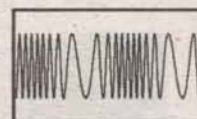
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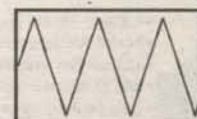
DC to 21.5 MHz linear and log sweeps



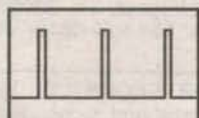
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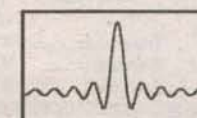
Ramps, Triangles, Exponentials



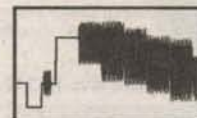
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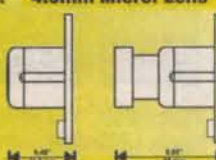


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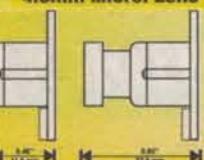


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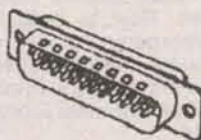
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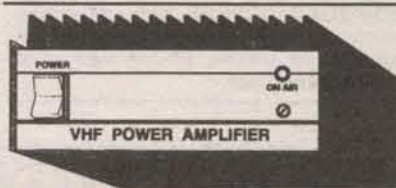


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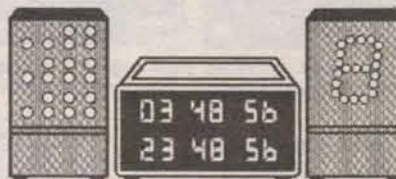
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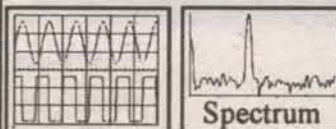
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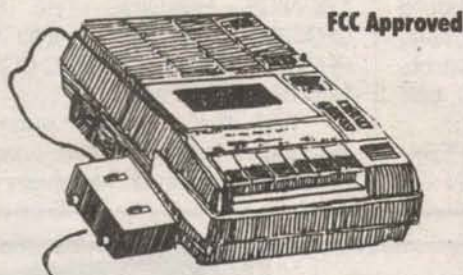
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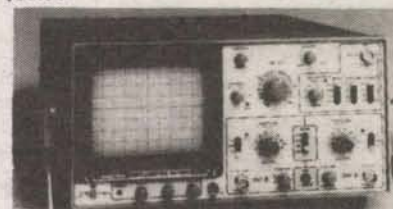


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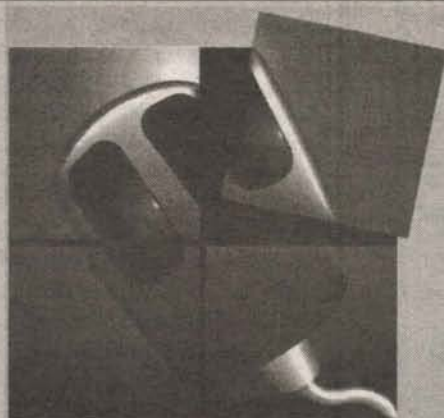
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If Explorer does not give a BSOD, restore your StartUp programs back to the "StartUp" folder one at a time, rebooting after each program is "restored," until Explorer gives the BSOD. Note: The last program you restored in the "StartUp" folder — that's the one causing the problem. It might be corrupted (reinstall it) or it needs an update (go to the web site

of the program author/distributor).

If, after these tests, you still get a BSOD with Explorer, you will have to re-install "the whole smack" of Windows software. If that doesn't solve the problem, your motherboard or expansion card(s) may be at fault. Either a loose IC or a "thermal" problem (i.e., dust accumulation, bad power supply fan) may be at fault.

NOTE: THE FOLLOWING OPERATIONS REQUIRE YOU TO OPEN UP

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Let the system reboot and play with it awhile. If you're fortunate, your Explorer BSOD problem may be gone. If it's still there, then I can't think of anything else to try short of replacing the motherboard.

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ANSWER TO #29911 - FEB. 1999

Amperite Co., Inc., 600 Palisade Ave., Union City, NJ 07087, telephone 1-800-752-2329, makes the relay you are seeking. It is their VPR series voltage protection relay.

For the specified voltage window, their part number is 120A100-130VPR.

This is a double pole double throw relay that plugs into a standard octal socket and it will close only when the input voltage is between 100 and 130 volts. If the voltage falls out of that window, the relay opens. The relay can also be special ordered with the required 100-second delay.

Alternatively, a standard DPDT time delay relay, also supplied by Amperite, can be connected to the VPR relay to provide the 100-second delay.

The voltage protection relay is available with any desired custom voltage window. Amperite parts can be ordered from such suppliers as Newark Electronics and Allied Electronics.

A. Caristi
Waldwick, NJ

ANSWER TO #29912 - FEB. 1999

A simple IR repeater circuit can be built with an inexpensive IR receiver module such as RadioShack part #276-0137, a 555 timer, an IR LED attached to a short two-wire cable, and several "glue" components.

The basic idea behind such a repeater circuit, is that the IR module receives the IR signal from the remote, which is riding on a 40KHz carrier. The IR module removes the carrier and sends the signal to the 555, which is set up as a 40KHz oscillator. The output from the 555 is then fed to the base of a transistor which is used to drive the IR LED attached to the end of the cable.

Assuming you have access to the Internet, a repeater circuit which

TECH FORUM

makes use of these parts is shown at <http://www.nysaes.cornell.edu/cc/staff/pool/electronics/irrepeat.htm>. (Just scroll down about half-way on the page to see the diagram.)

If you need more distance, you might want to look into the IR repeater sold by RadioShack, catalog #15-1959. This device uses RF rather than a cable to send the signal to the remote IR emitter. At around \$50.00, it's much more expensive than the do-it-yourself approach, but it might be worth it if the extended range (up to 100') is an issue.

Mark Winters
Drem, UT

ANSWERS TO #3993 - MAR. 1999

The website you're looking for is <http://www.dzn.com/w5es/electro.htm>

The "ElectraSlide Antenna" is based on an original design by Don Johnson W6AAQ, called the DK3. Some additional contact information:

Clay Emert K5TRW
cemert@dzn.com
2100 San Diego Ave.
El Paso, TX 79930
915-859-5502

Mike Nalbene
Trenton, NJ

ANSWERS TO #3993 - MAR. 1999

I have used a screwdriver antenna for about two years now. You can contact the manufacturer at T.J. Antenna Co./Nott Ltd., 3801-4001 La Plata Hwy., Farmington, NM 87401; 1-800-443-0966, E-Mail: judy@tjantenna.com. They call it the "Broadband BB3."

As for the operation, I would be happy to answer any questions about its operation via E-Mail.

Charlie E. Zalenski
via Internet

ANSWER TO #3996 - MAR. 1999

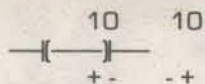
A "Non-Polarized Electrolytic" capacitor is just what it says: an electrolytic capacitor WITH NO POLARITY! Their "plates" are made in the same way as "regular" electrolytics except when they're put together, they are usually constructed with two "positive" plates.

Their use is typically in AC motors as "starting" capacitors, and other high-voltage "AC-intensive" applications.

If you cannot find an "exact" replacement NPO, or can find one with the right capacitance but not rated high enough (i.e., 200V instead of 300V), you can make your own NPOs using two regular high-voltage electrolytics wired IN SERIES, joining both NEGATIVE (-) leads together.

In other words, to create a 5uF, 300V (or higher voltage: you can always use a larger voltage cap as a substitute!) NPO, simply join a pair of 10uF 150V (or higher voltage) in series. (Remember: capacitance decreases in series circuits and work-

ing voltage increases — just add-up the individual cap voltages) like this:



Carefully insulate the joined leads and you have an "instant" non-polarized electrolytic.

For a source of NPOs, I would try Digi-Key Electronics www.digikey.com

or MCM Electronics www.mcmelectronics.com. Even if you can't find the NPOs, these firms do carry high-voltage electrolytics that you can make into "NPOs."

Ken Simmons
Auburn, WA

ANSWER TO #12985 - DEC. 1998

The TCM3105 Bell 202 modem IC is available from JDR Microdevices, 1850 S. 10th St., San

Jose, CA 95112-4018. They can be reached at 1-800-538-5000 [orders] or at www.jdr.com

In catalog #67C, it was priced at \$14.99 each in quantities of under 25 pieces.

It was also listed in a recent flyer from Debco Electronics, Inc., 4025 Edwards Rd., Cincinnati, OH 45209 for \$11.99 each. They can be reached at 1-800-423-4499

Continued on page 71



LEVITRON

"The Amazing Anti-Gravity Top"

This spinning top floats in mid air, supported by opposing magnetic forces. Includes floating top, levitron magnetic base, assortment of adjustment weights, lifter plate, levelling shims, and instructions. It takes some practice and a lot of patience to keep the top afloat, but the results are truly amazing! Levitron Floating Top \$39.95

mini keyboard

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A very small computer keyboard (measures less than 5-3/4" x 9-3/4") that takes up minimal desk space. Uses a PS2 connector, and keyboard enclosure is black. Great for applications requiring a complete keyboard in a limited space, and an ideal solution for those wanting something lightweight and compact for transporting.

Great for home or work applications!



optional keyboard adapter:
PS2 to 5 pin DIN \$3.95



Solar Panel
12v 100mA
\$19.95

Perfect for charging batteries, powering projects, light-duty emergency back-up, and other solar fun applications. These panels are framed and feature red and black alligator clip leads for easy attachment of most applications. approximate dimensions: 5.5" x 12.25" x 0.75"

PHOTON II MICROLIGHT

The popular photon microlight has been improved. These super-bright (better than 8 candellas!) LED lights are visible over a mile away. The LED is secured in a tough ABS case and offers a squeeze button for quick use, and a constant on slide switch for prolonged lighting needs. The lithium batteries last a very long time (10 year shelf life!) and are included. The light won't burn out because it is an LED! Specify your choice of five incredible bright colors. Great for home or office use, popular with fire and rescue professionals, pyrotechnicians, stage performers, and dimly lit restaurant patrons. PHOTON II microlights include a keyring and come in ruby red (\$13.50), amber yellow (\$13.50), orange (\$13.50), sapphire blue (\$17.50), turquoise (\$17.50), diamond white (\$17.50), and emerald green (\$17.50). Includes two replaceable 2016 lithium batteries.



127 THERMOCOUPLES PELTIER JUNCTIONS

The peltier junction is a solid-state thermoelectric device. Current applied to the device will produce heat on one side of the device and a cold surface on the other side.

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Ideal for applications from 3-12 VDC -- grab a battery and let your imagination run wild!

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MAIL ORDERS CALL TOLL-FREE 1-800-669-5810
FAX ORDERS (314)427-3147

Geophone vibration sensing kit

Detect a fly stomping across the desk! Well maybe not that sensitive, but almost.

These vibration sensors made by Geosensor® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration. Compact size, the unit measures approx. 1.6" high and 1.2" dia. The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses. COMPLETE GEOSENSOR KIT.....\$ 9.95

GEOSENSOR UNIT ONLY.....\$7.95



Power Up

Wireless Antenna Booster

A small square circuit (approx 1.5" x 1.5") that affixes to the back of your analog or digital cellular phone. It works with a patented design and white gold properties...This is not a miracle device, if the service is not there, this unit won't help. But, it does help reduce unwanted noise, dropped calls, and interference that may be experienced in office buildings, cars, parking structures, and weak electrical fields. Power Up may not be effective in some rural areas. \$19.95

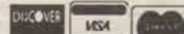
VOICE CHANGER KIT

Change your voice with this really cool kit! Using DSP (Digital Signal Processing), you can make a man sound like a woman, make a woman sound like a man, create scary monster sounds (just in time for halloween!), and have lots of fun. Use the special echo and vibrato modes for additional special effects. Kit features clip-on electret mic, removable speaker with metal case, sound effects selector switch, adjustable volume control, up/down pitch shifts, and step-by-step instructions. 3.5mm jacks for the microphone and speaker make it easy to connect to other audio equipment. Requires 4 AA batteries (not included.) \$49.50

TV TRANSMITTER KIT \$27.95

Tired of logging the VCR to another room to see a movie while Aunt Martha watches reruns of the Julia Child special on PBS? Sick of stringing wires through the house so Junior can watch the latest Power Ranger movie in the comfort of his room? Never fear, we've got the solution! This kit allows you to send any audio and video source, like a VCR or TV camera, to any TV set for up to 300 feet. With this little kit, you're the producer and the programming director of your own TV station. Tunable to any TV channel 2-6, runs on 12 VDC, and accepts standard audio and video signals. Optional matching case set, \$14.95

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Events

CALENDAR

APRIL 1999

APRIL 2-3

OK - MOORELAND - Hamfest. Tri-State AR Group, Duane Henderson KC5NID, 580-994-2223. E-Mail: kc5nid@pdl.net

APRIL 2-3-4

GA - AUGUSTA - Hamfest. Radisson Hotel & Conference Center, 2 10th St. Garden City Channel Masters CB Club, Inc., Moses 706-793-7828

APRIL 3

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CO - LONGMONT - Hamfest. Longmont ARC, Fred Pilz KB0JUD, 303-817-5526. Web: <http://www.qsl.net/larc>

APRIL 9-10

GA - ATLANTA - Southeastern VHF Conference. Southeastern VHF Society, Dick Hanson K5AND, 770-844-7002. E-Mail: k5and@prestique.net Web: <http://www.svhfs.org.svhfs>

APRIL 9-10-11

CA - FRESNO - Int'l DX Convention. Gordon Gorton W6NW. E-Mail: gordon@svpa.org E-Mail: w6nw@amateur-radio.org Web: <http://www.amateur-radio.org/ncdxc.org>

APRIL 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MN - ROCHESTER - Hamfest. Rochester ARC, John Scott N0HZN, 507-285-6522. E-Mail: n0hzn@aol.com

Web: <http://members.aol.com/rarchams/>

NC - MORGANTON - Hamfest & Computer Fair. Burke County Fairgrounds, Hwy. 181N (Exit 100 Eastbound, Exit 105 Westbound I-40). 8am-5pm. Talk-in: 147.15 (KAVLY repeater). Catawba Valley, Tom Taylor, 704-433-6205. E-Mail: kc4qpr@vistatech.net

NH - TWIN MOUNTAIN - Hamfest. Town Hall. 8am-2pm. VE Exams. Talk-in: 147.345. North Country ARC and LARK, Richard Force WB1ASL, 603-788-4428. E-Mail: bhabooks@together.net

TX - BRENHAM - Hamfest. Brenham ARC, Dan N5JUN, 409-836-8739. Bob KA5BOB, E-Mail: angdenis@tca.net

WA - SPOKANE - Hamfest. Spokane Community College, 1810 N. Greene St. 9am-5pm. VE Exams. Talk-in: 146.52 simplex, 147.32 repeater. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

APRIL 11

CT - BRISTOL - Hamfest. Insurance City Repeater Club, Jack McLaughlin WK1S, 860-621-6623. E-Mail: wk1s@aol.com Web: <http://www.connix.com/~pcb/icrc-file.htm>

IA - DELOIT - Hamfest. Denison Repeater Association, John Amdor III KD6MXL, 712-388-8042. E-Mail: johnmxl@radix.net Web: <http://www.radix.net/~johnmxl/deloit.html>

MA - FRAMINGHAM - Hamfest. Framingham ARA, Beverly Lees N1LOO, 508-626-2012

NC - RALEIGH - RARSfest. State Fairgrounds, Jim Graham Bldg. 8am-4pm. Raleigh ARS, Wilbur Goss WD4RDT, 919-266-9883. E-Mail: k4hf@juno.com

NY - MONTGOMERY - Hamfest. Valley Central High School, 1175 St. Rt. 17K. 8am-2pm. VE Exams. Talk-in: 146.160 in, 147.760 out 100 Hz PL tone. Orange County ARC, Edward J. Moskowicz N2XJI, 914-534-3492 eves. E-Mail: n2xji@banet.net

WI - MADISON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@hotmail.com

APRIL 17

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith KC4URL, 256-593-2516. E-Mail: kc4url@airnet.net

AZ - PHOENIX - Hamfest. Arizona ARC, George Cooney KQ7C, 602-274-6212. E-Mail: george@aztec.asu.edu

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

Web: <http://www.srv.net/~w4vrv/hamfest.htm>

CANADA - TORONTO - Durham Region Hamfest. Ian Smith VE3ITG, 905-427-4873. E-Mail: ve3itg@rac.ca

Web: <http://www.globalserve.net/~ismith>

FL - MIAMI - Hamfest. Flamingo, Univ. of Miami ARC UM Campus, Physics Parking Lot. Talk-in: 146.865 (-). Walt W4DWN, 305-895-0398

56 April 1999/Nuts & Volts Magazine

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:

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Events Calendar

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Fax 909-371-3052

E-mail events@nutsvolts.com

COMPUTER SHOWS

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E-Mail: info@agishows.com

<http://www.agishows.com>

Blue Star Productions

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<http://www.supercomputersale.com>

Computers And You, 734-283-1754.

www.al-supercomputersales.com

Computer Central Shows

847-412-1900 & 1-888-296-6066.

E-Mail: compcent@magsinet.net

www.computercentralshows.com

Five Star Productions

810-890-0988 E-Mail: jeff@fivestar

www.fivestars.com

Georgia Mountain Productions

706-838-4827.

E-Mail: gamtpro@blrg.tds.net

www.georgiamountain.com

Gibraltar Trade Center, Inc.

734-287-2000. Taylor, MI.

Gibraltar Trade Center, Inc.
810-465-6440. Mt. Clemens, MI.

KGP Productions

1-800-631-0062, 732-297-2526.

E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229

<http://www.marketpro.com>

MarketPro, Inc., 301-984-0880.

E-Mail: md@marketpro.com

<http://marketpro.com>

Narisaam Computer Show

770-663-0983.

E-Mail: narisaam@aol.com

Web: <http://www.showsale.com>

Northern Computer Shows

978-744-8440

E-Mail: inquiries@ncshows.com

Web: ncshows.com

Peter Trapp Computer Shows, 603-

272-5008. Web: www.petertrapp.com

Web: <http://www.seorf.ohiou.edu/~xx017/hamfest.html>

OH - CANFIELD - Hamfest. Twenty Over Nine RC, Don Stoddard N8LNE, 330-793-7072

APRIL 30-May 1

LA - BATON ROUGE - LA Section Convention. Baton Rouge ARC, Herb Ramey W5LSU, 504-654-6087. E-Mail: daveramey@worldnet.att.net Web: <http://www.brarc.org>

MAY 1999

MAY 1

AL - MOULTON - Hamfest. Bankhead ARC, Rex Free KN4CI, 256-905-0822. Ed Weatherford K4EKW, 256-974-0436.

Web: <http://www.symmetric-inc.com/N4IDX>

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CANADA - ONTARIO - OTTAWA - Hamfest.

John Barnhardt VE3ZOV, 613-521-8910

CO - MONUMENT - Hamfest. Pikes Peak RAA,

Robert Ryals K1QGF, 719-265-9950. E-Mail:

rryals@pcisys.net Web:

<http://www.qsl.net/ppraa/swapfest.html>

KY - FALLSBURG - Hamfest. Big Sandy ARC,

Fred Jones WA4SWF, 606-638-9049

MD - GRAYSONVILLE - Hamfest. Kent Island &

Anne Arundel ARCs, Tony Young WA3YLO, 301-

262-1917. E-Mail: tony@juno.com Web:

<http://home.att.net/~n3szw/aarc.html>

MI - CADILLAC - Swapmeet. Cadillac Middle

School. 8am-1pm. VE Exams. Talk-in: 146.98.

Wexauke ARC, Dan KE8KU, 616-775-0998.

E-Mail: ke8kudan@juno.com

SC - WINDSOR - Hamfest. Salkehatchie ARS, Bill

Chapman N3WCM, 803-641-0666

TN - NASHVILLE - Hamfest. Vaughn Bldg., TN

State Fairgrounds. Nashville ARC, Bob Malone

WB5ZDS, 615-865-6225. E-Mail:

WB5ZDS@juno.com

WI - CEDARBURG - Hamfest. Ozaukee RC, Joe

Holly AA9HR, 414-377-2137. E-Mail:

561-641-8244

NJ - HARMONY - Hamfest. Warren County Farmers Fairgrounds, Rt. 519 N. 8am-2pm. VE Exams. Talk-in: 147.375+ 146.730. Cherryville RA II, Inc., Randy Vance N2MQZ, 908-788-4080 or 908-454-4370. E-Mail: n2mqz@aol.com Web: <mailto://w2cra@qsl.net>

NM - ALBUQUERQUE - Hamfest. Albuquerque ARC & AR Caravan Club, Chuck Opdyke KC5GA, 505-858-0306. E-Mail: n5oqi@worldnet.att.net

VA - CHESAPEAKE - Hamfest. Chesapeake AR Service, Jim Cannon KF4RQQ, 757-382-0193. Web: <http://www.qsl.net/cars>

WA - VANCOUVER - Hamfest. Salmon Creek American Legion Post 176. 8am-2pm. VE Exams. Clark County ARC, Luther Brisky KC7KVL, 360-896-8909 or 360-254-5082. E-Mail: lwayne@e-z.net Web: <http://www.w7aia.org>

APRIL 25

DE - NEW CASTLE - State Convention. Nur Temple, Rt. 13 N. 9am-2pm. VE Exams. Talk-in: 147.225+ or 224.220/R. Penn-Del ARC, Hal Frantz KA3TWG, 302-793-1080. E-Mail: hfrantz@snip.net Web: <http://www.magpage.com/pennndel>

FL - GAINESVILLE - Hamfest. Gainesville ARS, H. Walter Johnston W4TKE. E-Mail: w4tke@juno.com E-Mail: w4tke@gator.net

IL - ARTHUR - Hamfest. Moultrie/Douglas County Fairgrounds. 8am-1pm. Talk-in: 146.055/146.655 & 449.275/444.275. Moultrie ARK, Ralph Zancha WC9V, 217-873-5287 or 217-543-2178. E-Mail: rzancha@one-eleven.net Web: <http://home.stinet.com/~jhudson/hamfest.html>

IL - GALVA - Hamfest. National Guard Armory. 8am-2pm. VE Exams. Talk-in: 145.4900 88.5 PL, 146.460 simplex. AARO, Bill Anderson WB9TEW, 309-932-3023. E-Mail: bill@inw.net

NY - Poughkeepsie - Convention. Mt. Beacon ARC, Ken Akasofu KL7JQC, 914-485-9617. E-Mail: k7jrc@iname.com Web: <http://www.mhv.net/~fritzing>

OH - ATHENS - Hamfest. City Recreation Center. 8am-3pm. Talk-in: 145.15 MHz (-600 offset). Athens County ARA, Drew McDaniel W8MHV, 740-592-2106. E-Mail: dmcDaniell@ohiou.edu

ID - IDAHO FALLS - Hamfest. Elks Lodge, 640 E. Elva St. VE Exams. Talk-in: 443.00 MHz + QHF, 147.15 MHz + VHF. Eastern Idaho UHF Society, Jay Greenburg WA4VRV, 208-524-1388. E-Mail: w4vrv@srv.net

KY - MURRAY - Hamfest. Murray State University ARC, Pat Compton KF4FMZ, 502-762-6433. E-Mail: patrick.compton@murraystate.edu Web: <http://mursuky.edu/clubs/msuarc/hamfest.htm>

MN - BLAINE - Hamfest. National Sports Center, 35W, Exit #32. 7:30am-3pm. Jerry Dorf N0FWG, or Harriet Johanson 612-537-1722. E-Mail: jerryd@skypoint.com

MO - JOPLIN - Hamfest. Joplin ARC, Ray Brown KB0STN, 417-781-4967. E-Mail: raybrown@ipa.net Web: <http://www.joplin-arc.org>

OK - LAWTON - Hamfest. Lawton Ft. Sill ARC, Bob Morford KA5YED, 580-355-6120 or 580-353-8074

TN - DAYTON - Hamfest. Rhea County ARS, Bob Jordan KN4VY, 423-775-3225. E-Mail: kn4vy@volstate.net Web: <http://webcube.volstate.net/~ko4sy/>

TX - BELTON - Hamfest. Bell County Expo Center. Talk-in: 146.820, PL 123.0. Temple ARC, Mike LeFan WA5EQQ, 254-773-3590. E-Mail: hamexpo@tarc.org Web: <http://www.tarc.org>

APRIL 18

CT - HARTFORD - 1999 Trinity College Fire-Fighting Home Robot Contest. Trinity College campus. Jake Mendelsohn, 190 Mohegan Dr., West Hartford, CT 06117. E-Mail: JMENDEL141@AOL.COM Web: <http://www.trincoll.edu/~robot>

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Altembernd KA1MQX, 617-253-3776. Web: <http://web.mit.edu/w1mx/www/swapfest.html>

MN - SHAKOPEE - Hamfest. Canterbury Park. 12pm-5pm. VE Exams. Talk-in: 147.165+.

SMARTS, Helen Haynes WBOHOX, 612-556-0077. E-Mail: smarts@maven.mn.org Web: http://www.wavefront.com/~tim_fogarty/

PA - MONROEVILLE - Hamfest. Two Rivers ARC, Michael Kowalcheck, Jr. KV3L, 412-751-9657. E-Mail: w3oc@nb.net

APRIL 23-24

AR - LITTLE ROCK - Hamfest. Expo Center, Exit 126, I-30 SW. Fri: 4pm-9pm, Sat: 8am-4pm. Jim Blackmon K5VZ, 870-246-7833 H, 870-246-6734 W. E-Mail: lrhamfest@usa.net Web: <http://www.aristotle.net/~ares/hamfest/>

FL - GAINESVILLE - Hamfest. Alachua County Fairgrounds, SR 222. VE Exams. Talk-in: 146.820. Steve King KC6WCH, 352-375-8023 eves. only. E-Mail: gars@afn.org

APRIL 24

AR - BENTONVILLE - Hamfest. Benton County Radio Operators, Betty Weiberg N0XWQ, 417-435-2332

CA - ARMONA - Hamfest. Hanford Fraternal Hall, 10th Ave. @ Florida. Talk-in: 145.11, 147.33, 224.44 or 441.900. The Kings ARC, Rick WB6VFZ, 209-945-2266. Doug KC6BGQ, 209-582-0949 or 209-584-5414

CA - SONOMA - Hamfest. Sonoma Valley Veteran's Memorial Bldg., 126 1st St. W. 8am-12pm. VE Exams. Talk-in: 145.35, -600 PL 88.5. VOMARC, Darrell Jones WD6BOR, 707-996-4494

IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCV, 515-287-6542

FL - LANTANA - Flea Market. Next to Pizza Hut, 6170 S. Congress Ave. 7am-12pm. Talk-in: 146.67. The Major Armstrong FM Assn., Jeff Beals WA4AW, 561-586-5120. Al West W4SDC,

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WI - SUPERIOR - Hamfest. Arrowhead RAC, Jeff Daniels N0VQF, 218-485-8131

MAY 1-2

AL - BIRMINGHAM - Convention. Zamora Temple, off I-459 E. Birmingham ARC, Glenn Glass, 205-681-5019. Dan Morgan KB4MDI, 205-822-5242, E-Mail: kb4mdi@scott.net Web: <http://bro.net/barc/fest.html>

IL - ELGIN - CoCoFest. Elgin Plaza Hotel, 345 W. River Rd. The Glenside Color Computer Club, Tony Podraza, 847-428-3576.

E-Mail: tonypodraza@juno.com

Web: <http://members.aol.com/clubbbs/glenside>

NJ - EDISON - Trenton Computer Festival. NJ Convention Center, Raritan Center. Sat: 9am-5pm, Sun: 9am-4pm. KGP Productions, Inc., Marin Light, 1-800-631-0062. E-Mail: kgp@mail.com

Web: www.tcf-nj.org
TX - ABILENE - West Texas Section Convention. Key City ARC, Peggy Richard KA4UPA, 915-672-8889. E-Mail: jlmr@swconnect.net Web: <http://www.westex.net/kcarc/hamfest.html>

MAY 2

IL - DECATUR - Hamfest. Cenois ARC, Tracy Ruble N9VIM, 217-423-0314. E-Mail: n9vim@springnet1.com

IL - SANDWICH - Hamfest. Kishwaukee ARC, Bob Yurs W9ICU, 815-895-3219. E-Mail: w9icu@tbcnet.com Web: <http://tbcnet.com/~jleopard/hamfest.htm>

HAGERSTOWN - Hamfest. Community College, Athletic and Recreation Bldg. 8am-3pm. Talk-in: 147.090+. The Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769.

E-Mail: kb8zqm@intrepid.net

Web: <http://www.erols.com/rjlong61/ara>

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053

PA - WRIGHTSTOWN - Hamfest. Warminster ARC, Tony Simek N3YNH, 215-674-5218. E-Mail: tsimek@aol.com

WV - RIPLEY - Hamfest. Jackson County ARC, Gary Casto AG8RY, 304-372-2849

MAY 7-8

NH - ROCHESTER - Hamfest. Hosstraders, Joe Demaso K1RQG, 207-659-3492

MAY 8

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

KY - DAWSON SPRINGS - Hamfest. Curt Beshear KE4UZE, 502-797-9117. E-Mail: ke4uze@juno.com

OK - MCALISTER - Lake Eufaula Hamfest. John Petersen KM5ES, 918-452-2279. E-Mail: km5es@cwis.net

SC - ANDERSON - Hamfest. Anderson County Fairgrounds, Hwy. 29 Business. Talk-in: 146.610. Blue Ridge ARS, Robert G. Watson W4RGW, E-Mail: w4rgw@backroads.net

Web: <http://www.brars.org>
TX - CHICOTA - Hamfest. Red River Valley ARC & ARES of Lamar County, Kevin "Mort" Winslow N3YNL, 214-894-3088.

E-Mail: 4n3ynl@uniconp.net
WI - MANITOWOC - Hamfest. County Expo Center, County Hwy. R. 8am-12pm. VE Exams. Talk-in: 146.01/61. Mancorad RC, Red 920-684-3733, Fred 920-682-9312

MAY 10

MA - GREENFIELD - Hamfest. Franklin County ARC, Richard Strycharz KD1XP, 413-665-2211. E-Mail: kd1xp@arrl.net

MAY 14-15-16

OH - DAYTON - Hamfest. Dayton ARA, Dick Miller N8CBU, 937-427-3109. E-Mail: chair@hamvention.org

Web: <http://www.hamvention.org>

MAY 15

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In, 619-561-0052

CANADA - ONTARIO - ETOBICOKE - Hamfest. Skywide ARC, Murray Smith VA3KTL, 416-621-1233. E-Mail: murray.smith3@sympatico.ca

GA - STATESBORO - Hamfest. Statesboro ARS, Martin Holzman WB4MOG, 912-764-5959. E-Mail: mart@bulloch.com Web: <http://www.cs.gasou.edu/stars/>

ID - CALDWELL - Hamfest. Snake River ARC, Don Ingram KB7UKP, 208-459-2459. E-Mail: ingramde@cyberhighway.net

NC - GREENVILLE - Hamfest. East Carolina Antique Radio Club, Herman Schnur K4CTG, 252-752-2264

TN - CLARKSVILLE - Hamfest. Clarksville Amateur Transmitting Society, Hank Koebler N3ORX, 931-645-5206. E-Mail: n3orx@arrl.net

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will be large enough to hold the rest of the parts. Cut out the front-panel hole for the meter, but mount it last. A suggested layout would be to follow the layout in Photo D from Part 1. Drill the holes for the ON/OFF switch and the photo cell. Photo A shows mounting details for the photo transistor. Photo B gives that

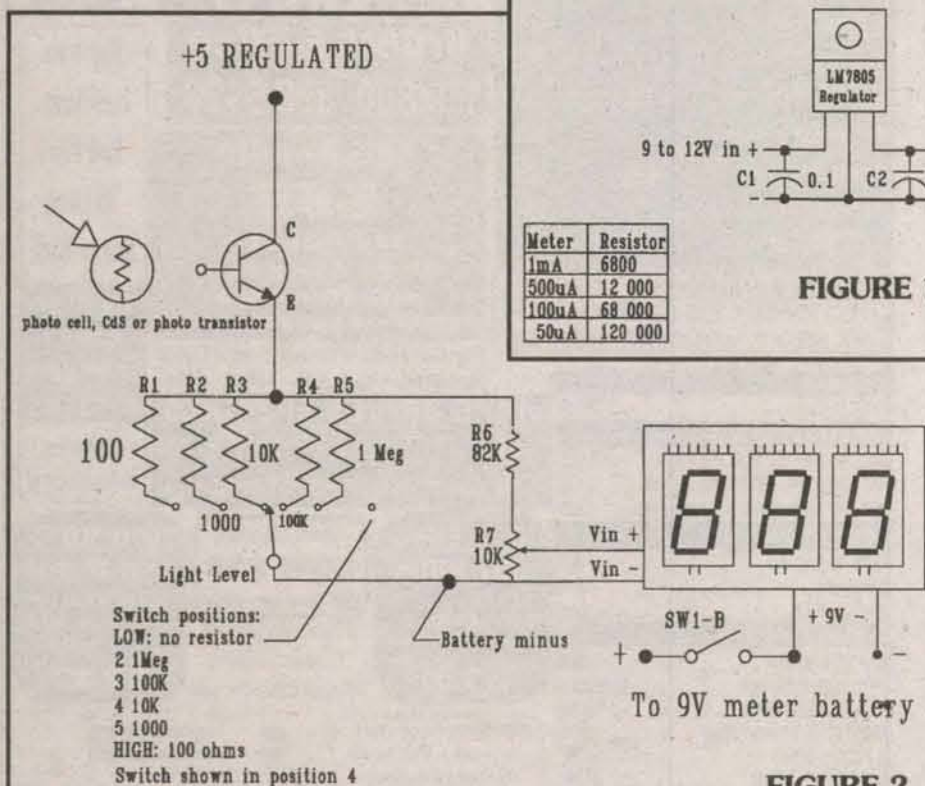


FIGURE 1.

For details of SW1-A and the regulator, see Figure 4.

information for the CdS cell.

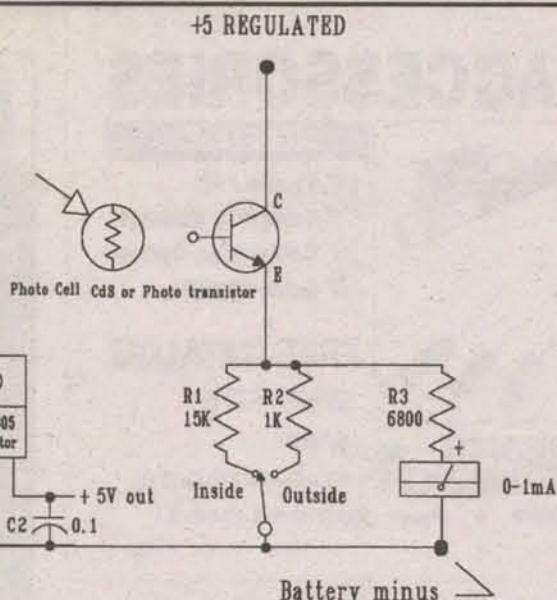
The back of the DPM has easy-to-read markings telling where to connect the battery and the signal. The signal connects to the Vin and the G terminals. The battery plus goes to the terminals marked 9V and battery minus. Check the instructions that come with your meter.

Testing It

Once you have the parts installed in the box, doublecheck to see that the batteries go to the proper places. Then, turn on the POWER switch.

Table below shows suggested values for scaling resistor R3, with common meters.

Simplified drawing of light meter with analog readout. Instead of the photo transistor, a CdS photo cell may be used. One is shown to the left of the photo transistor.



recheck the wiring to and from the regulator, as well as the wires from the RANGE switch. While you are at it, when you have the battery connected to the regulator, take a voltmeter and make sure that the regulator puts out five volts.

Calibrating It

When you get readings that seem to follow the RANGE switch, you can "calibrate" it. This is strictly an arbitrary calibration. I took my meter outside and set the RANGE switch for the HIGH position. Then, with the diffuser on and the

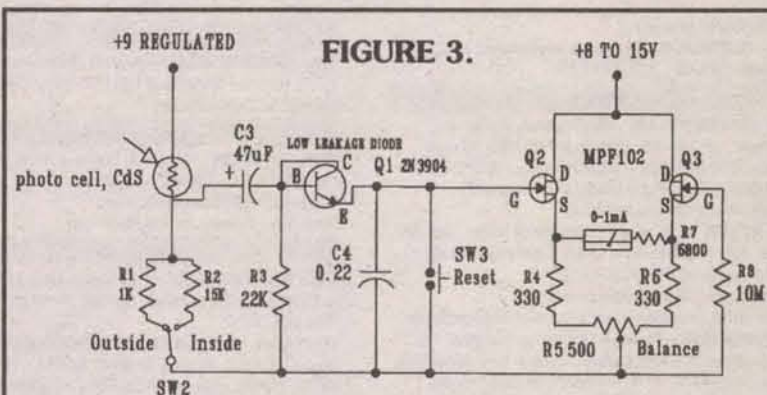


FIGURE 3.

SW1, ON/OFF, connects the battery to the regulator. C1 and C2 go on the regulator, see Figure 5. Q1, a 2N3904, is connected as a diode. Analog display with CdS sensor will work, but photo transistor gives better results. Typical values shown for working model: Photo C. Using 9V instead of 5V gives a bit more sensitivity. However, this requires a 12V battery; somewhat less inconvenient than a 9V battery. See Figure 5 for details of regulator.

unit pointing toward the sun, I set the sensitivity control — the 10 K pot — for an on-scale reading, somewhere around 1,900. Taking it into a shady area, the reading dropped until I could set the RANGE switch to a lower setting. Going inside, it was possible to put the switch on the LOWest setting. There, it would read the light in a dimly-lit room or the light on the TV screen.

The next step would be comparing those readings with a known meter. Lacking a

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calibrated light meter, you could take a series of readings and write down the conditions. While doing that, take a series of pictures, possibly of your new light meter, and write down the f stops and the shutter speeds. Keep that information handy as that becomes your calibration chart. It tells you what readings you got for a certain set of lighting conditions and how you set your camera to get a good picture. Once you have that information, you can expect repeatable readings from the meter.

Strobe Meter with Analog Display

Figure 3 gives the circuit for the strobe meter with analog display. The parts can go on a piece of perf board as shown in Photo D. That would also serve as a suggested layout for

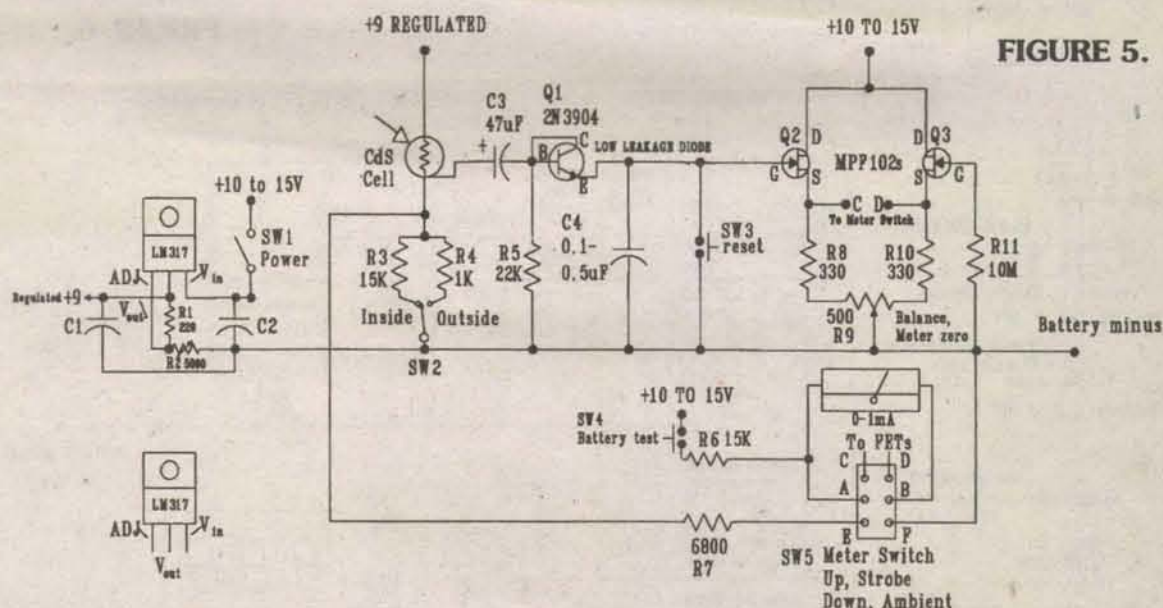
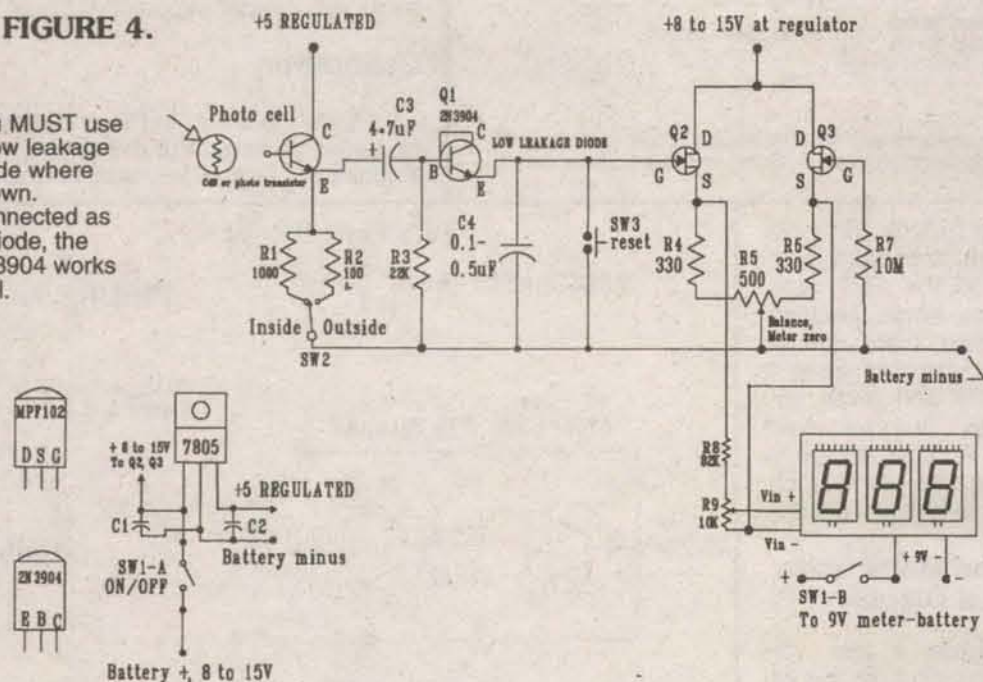


FIGURE 5.

FIGURE 4.

You MUST use a low leakage diode where shown. Connected as a diode, the 2N3904 works well.



For Battery test: POWER switch off, STROBE/AMBIENT switch in AMBIENT position. Press TEST button, full scale = 15 volts. As an option, you could take the RESET circuit from Figure 7 (Part 2) and add it to this circuit.

that set for zero, release the RESET button (remove the clip). The meter should stay on zero. With the INSIDE/OUTSIDE switch set to INSIDE, point the unit at a strong light, cover the sensor, then suddenly uncover the sensor. The meter should jump upscale. Of course, if you have a strobe handy, put the switch on the OUTSIDE position and fire the strobe at it.

If you have an on-scale reading, the meter should hold that reading for several minutes; at least long enough for you to get a reading. Push the RESET button and try it again. Move the strobe about two-three times the distance and fire again or, just point the strobe away from it for the next test shot. Changing the light into the meter should give varying readings.

If the meter hits the pin for the conditions that you want to use — distance to the meter, high power strobe, etc. — then decrease the size of the 1 K resistor, increase the size of the Hold capacitor, or both. I derived the values shown here from a nominal 60 watt second

either the strobe, the analog, or the combined system. The difference amounts to about five parts and an external switch. So, for just the strobe meter, put the parts on a board and run wires to the switches, the battery, the photo cell, and the meter.

Watch the 47 uF capacitor. The plus side of it must connect to the emitter of the photo transistor, or the CdS photo cell, where that connects to the INSIDE/OUTSIDE switch.

As mentioned earlier, if you can not find a 500 ohm control, a 1,000 or even a 1,500-2,200 ohm control will work. Preset the Balance control to about the center of its range. Pay close attention to the wiring on the FETs. When you have it all wired, lean on the RESET button while turning on the Power switch. If all goes well, the meter will show some life.

Balance

With your finger on the RESET button, or an alligator clip across it, adjust the Balance control for zero on the meter. The control should let you move the meter a little distance either side of zero. Once you have

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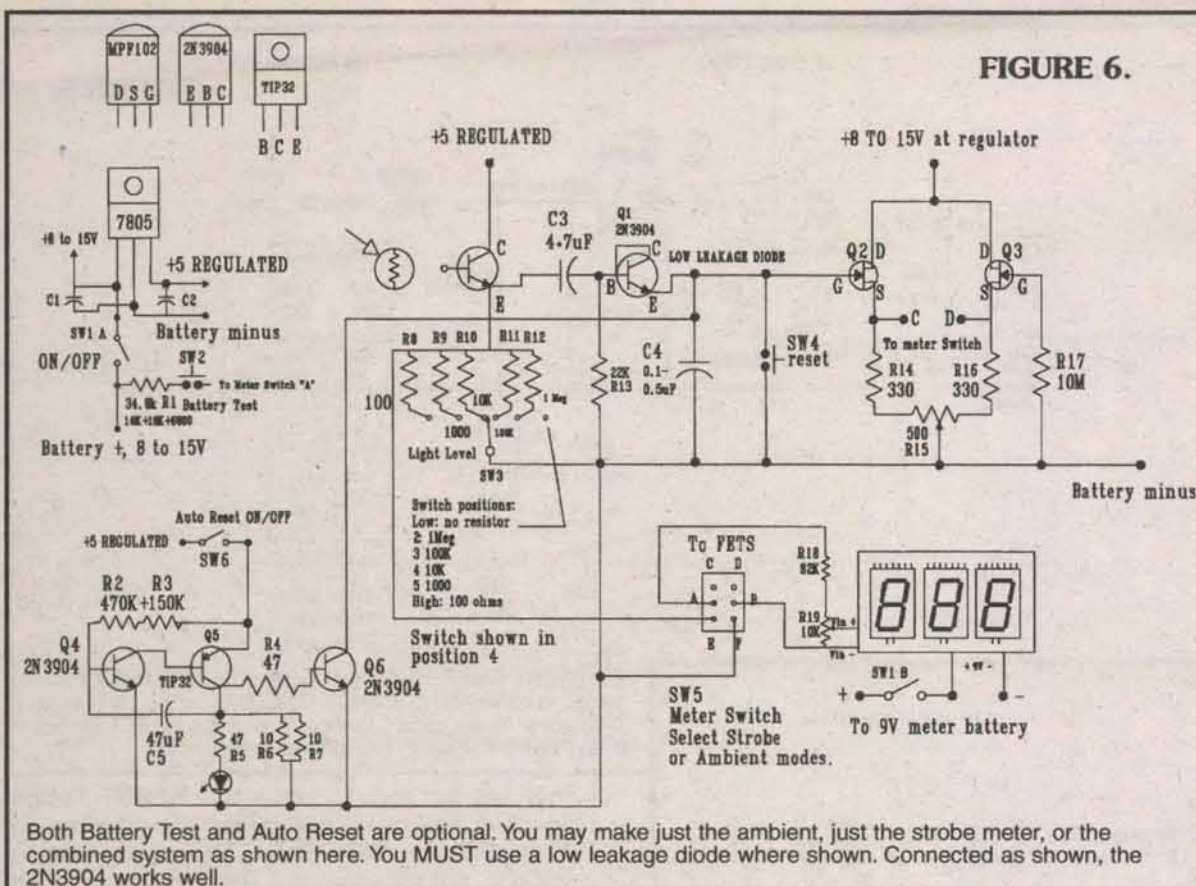


FIGURE 6.

resistor, and the 10 K pot. With the higher sensitivity DPM, we use a five-volt regulator.

Again, the parts may go on a piece of perf board. Check the photos, E for how to mount the photo transistor, or F for mounting the CdS cell. Add the external controls/switches, and the batteries. Check the wiring, hold down the RESET button, and turn on the power. The DPM should show some numbers. Adjust the 500-ohm Balance control for zero on the read-out.

If the zero adjust seems to have a lot of drift, recheck the wiring. If it seems to hold zero, let go of the RESET switch, then change the RANGE switch. That usually puts a pulse into the system. Otherwise, fire a strobe at it. Hit the RESET button and try it again. Point the strobe away from it and fire again. That should give a lower reading unless you are in one of the classic strobe test rooms: a small room with everything painted bright white.

Calibration

Place the meter in the area that you plan on taking pictures. Put the strobe, or strobes, in position. Fire a few test bursts. Note the

strobe at practical working distances; in my case, about 10 feet.

Keep in mind that the FET voltmeter as shown here can handle input voltages up to about four volts. After that, it saturates. Normally, this circuit would have a voltage divider across the front end, where the Hold cap is, to keep the input voltage to the FETs at the one-two volt level. As noted before, you can not put a voltage divider there since that would kill the 'sample and hold' feature.

Fine Tuning

You can trim the sensitivity by changing the value of the 6,800-ohm resistor that is in series with the meter. That is the resistor in the very top right side of Photo D. You may make it adjustable by putting a 10 K pot in series with it. That would cut the sensitivity of the metering circuit by more than half. Keep in mind that too much input voltage to the gate will overdrive the FET voltmeter, so that you do not chase yourself in circles wondering why the meter gives inconsistent readings. Worse yet, as happened to me with the digital version, it read the same for test shots from 5 to 15 feet.

I went to a less sensitive range. Trimming the 1 K resistor or increasing the size of the Hold

cap to reduce the input voltage, to prevent overdrive to the FET gate, may be better choices. As I said, more options than ... but that gives it flexibility and gives you choices, if you want them. Another choice is making the strobe-only meter with digital display.

Strobe Meter with Digital Display

Figure 4 lets you view the diagram for the strobe meter with digital display without having to sort out the circuit from the complete diagram, Figure 5.

Note that the main difference between Figures 3 and 4 is the metering circuit. Here, in Figure 4, we add the signal conditioning resistors for the DPM, the 82 K

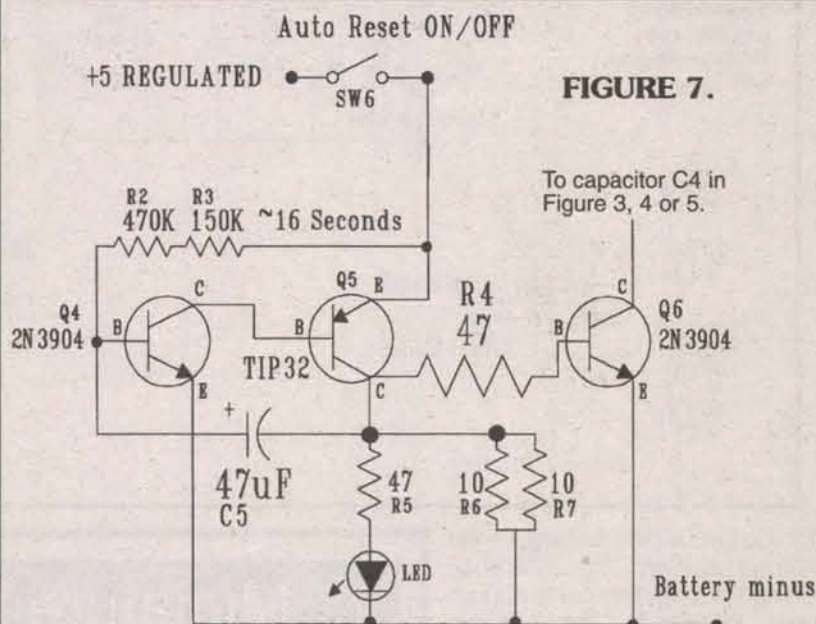


FIGURE 7.

When turned ON, this three-transistor circuit will reset the HOLD capacitor for you. The values shown give a reset pulse about once every 16 seconds. The LED gives a friendly wink to let you know that it has reset the capacitor, returning it and the display to zero, making the system ready to receive the next light burst from your strobe.

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TABLE II. AMBIENT LIGHT INSIDE

LM1	LM2 A	LM3 D
12K	1.6	738-L 712-2 450-3 86-4 1982-2
4800	4.5	

TABLE III. AMBIENT LIGHT OUTSIDE

LM1	LM2 A	LM3 D
175 Ohms	7-1/2 (outside)	350-H, 1900-5 Bright sun for ASA 200, f16@1/200
215 Ohms	6 (outside)/ 12 (inside)	92-H, 930-5 Refl. off light surface, without diffuser
600 Ohms	3 (outside)/ 9 (inside)	218-5, 1860-4 Shaded area, indicated settings: f5/6@1/125

This table shows readings for the three meters under the same outside lighting conditions.

TABLE IV. STROBE, 16WS

LM2 A	LM3 D
11.7	1128-5
8	1120-5
4	1095-5

Small, directional strobe. Readings on analog and digital light meters.

TABLE V. STROBE, 60WS

LM3 D	Indicated Settings ASA 200
600-H	10 FT Brn Hd
730-H	10 FT Blu Hd
600-H	12 FT Brn Hd
690-H	12 FT Blu Hd

60WS power pack and two different heads. The blue head has almost one stop more light.

TABLE VI. STROBE, 60WS GRY HD

LM2A	LM3 D	12 Feet
7-1/2	90-H	
7-1/2	1105	

Readings from unknown head. Compare with known head to get starting point.

TABLE VII. EXPOSURE VALUES

EXP VAL	f	1/T	ASA
13	16	25	25
14	16	50	50
15	16	125	100-125
16	16	200	200-250
17	16	400	400

TABLES SHOWING LIGHT VS. READINGS FOR VARYING SOURCES.

NOTES:

LM1 is the simple light meter.
LM2 A is the analog meter.
LM3 D is the digital light meter.
Numbers followed by a -2 or -H indicate the range on the digital light meter.
Numbers next to (outside) or (inside) indicate switch setting on the analog meter.
Table II show readings for room lighting. Note several scales on the digital meter. The last reading indicates increased light level.

Without a doubt, the meter(s) that you build will have different readings for similar conditions. That does not mean that these readings are right or wrong. These are the readings that I got and how they relate to one film speed. Readings for Tables IV-VI are average of several shots. Table VII gives some common exposure values. Some equipment uses these numbers instead of f/stops and shutter speeds.

to fit the pre-drilled holes. The board will accommodate larger pots, I just did not happen to get them. One other thing, the board calls for MPS102s that should read MPF102. Other than that, I found the board a real time saver.

Stuffing the Board

On printed circuit boards, I usually put on the resistors first, then the next taller parts, and so on. I would put the regulator on last as it is the most likely to get a broken lead if the board is turned over many times after you put the regulator on it. After stuffing the board, run the wires that go to the switches, controls, etc. CAREFULLY inspect the bottom (the solder-side) of the board for accidental connections. Sometimes a wire from a component may stick out and touch the run going to another part. Sometimes a bit of solder will bridge two circuit runs. Look for that and if you find it, fix it.

Board Contamination

While most of the circuits associated with these instruments are non-critical, the Hold cap used in the STROBE mode needs some consideration. The board must be clean. After putting the PCB version together, it did not want to hold the reading from the strobe. After a while, I traced it to 'leftovers' on the board.

With the power removed, the board got a good scrubbing with a stiff-bristled brush and rubbing alcohol, in a WELL ventilated area. After that, it held the charge.

readings, write them down. The Tables II-VI show some examples. Most likely, you already know what f stops go with a particular strobe and a given distance. Once you have established that, you can compare readings obtained with other strobes. At most, a short roll of film run through the processing lab should confirm your settings or, at worst, indicate which way to make adjustments.

Complete Analog System

So far, we have looked at simple light meters in 'bite-size' pieces. Relatively simple, easy-to-construct meters that will measure light and give us consistent readings. They have gotten progressively more complex. In exchange, they have done more for us. Now we will look at combined systems: light meters that will measure ambient or strobe light in one instrument. We will start with what I consider the simpler system, the analog unit.

Figure 5 shows the circuit for the entire system. Photos B and E give interior views. Photo C

from Part 1 showed the finished unit. In addition to the other features of the simpler system, it has a battery test and the meter switch. The meter switch connects the analog meter to one of two circuits.

In the Ambient position, it ties the meter to the cold side of the CdS photo cell (or to the emitter of the photo transistor) and to the battery return, circuit common. In the Strobe position, the switch connects the meter to the sources of the FETs. Both circuits remain active all of the time; you select which one you want.

Probably the most convenient way to put this one together would be to get one of the printed circuit boards from Fred at Far Circuits. They save a LOT of time. They have an easy-to-read silkscreen on the component side of the board. That lets you pick your parts and stick them on the board; quite a bit handier than the prototype version. Otherwise, you can just use the layouts, Figures 8-13, if you like to do your own boards.

A close look at this board, Photo E, shows that the controls need a bit of 'adjusting' in order

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PARTS LIST

Parts List Figure 2

Simple, Stand-Alone, Ohmmeter for measuring light
 R1 1000 ohm pot, or See Table in Figure 2
 R2 1000 ohms, or See Table in Figure 2
 R3 56-100 ohms
 Battery 1-1/2 volts and holder
 Photo Cell CdS 276-1657
 SWITCH Single Pole 3 Position
 Meter 22-410 (0-1mA) or see table
 Meter 910-0388 (0-1mA Tech America)

Parts List Figure 7

Ambient Light Meter with Analog Readout
 R1 15K C1 0.1uF/15V 272-1069 Photo Cell CdS or Photo transistor 276-1657 or 276-145
 R2 1K C2 0.1uF/15V 272-1069
 R3 6800 or See Table in Figure 7 Regulator LM7805, LM7806, LM7808 Pick one
 Meter 22-410 (0-1mA) Meter 910-0388 (0-1mA Tech America 1-800-877-0072)
 Diffuser/holder for photo cell 272-340

Parts List Figure 8

Ambient Light Meter with Digital Display
 R1 100 C1 0.1uF/15V 272-1069
 R2 1000 C2 0.1uF/15V 272-1069
 R3 10,000 Photo Cell CdS or Photo transistor 276-1657 or 276-145
 R4 100,000 Diffuser/holder for photo cell 272-340.
 R5 1,000,000 LCD Panel Meter PM-128 (Circuit Specialists 1-800-528-1417)
 R6 82K SW1 ON/OFF, DPDT Toggle switch 275-626
 R7 10K pot SW2 LIGHT LEVEL, 2P 6 position Rotary Switch 275-1386

Parts List Figure 9

Strobe Light, Analog Display
 R1 1000 C1 0.1uF/15V 272-1069
 R2 15K C2 0.1uF/15V 272-1069
 R3 22K C3 10-50uF/15V 272-1024, 1026 or 1027
 R4 330 C4 0.22uF/15V 272-1070
 R5 500 ohm pot, up to 2200 ohms ok. Q1 2N3904 276-1617 (Pkg of 15)
 R6 330 Q2 MPF102 276-2062
 R7 6800 Q3 MPF102 276-2062
 R8 10 Meg Diffuser/holder for photo cell 272-340.
 Photo Cell CdS or Photo transistor 276-1657 or 276-145
 Meter 22-410 (0-1mA) Meter 910-0388 (0-1mA Tech America 1-800-877-0072)
 SW1 ON/OFF, DPDT Toggle switch 275-626
 SW2 INSIDE/OUTSIDE, SPDT Toggle Switch 275-625, 635
 SW3 RESET, SPST Push Button Switch 275-1556

Parts List Figure 10

Two-Range Strobe Level with Digital Display
 R1 1000 C1 0.1uF/15V 272-1069
 R2 100 C2 0.1uF/15V 272-1069
 R3 22K C3 4.7-50uF/15V 272-1024, 1025 or 1026
 R4 330 C4 0.22uF/15V 272-1070
 R5 500 ohm pot, up to 2200 ohms ok.
 R6 330 SW1 ON/OFF, DPDT Toggle switch 275-626
 R7 10Meg SW2 HIGH/LOW SPDT Toggle Switch 275-625, 635
 R8 82K SW3 RESET, SPST Push Button Switch 275-1556
 R9 10K pot Diffuser/holder for photo cell 272-340.
 LCD Panel Meter PM-128 (Circuit Specialists 1-800-528-1417)
 Photo Cell CdS or Photo transistor 276-1657 or 276-145

Parts List Figure 11

Strobe/Ambient Light Meter with Analog Display
 R1 220 C1 0.1uF/15V 272-1069
 R2 5000 Pot C2 0.1uF/15V 272-1069
 R3 15K C3 4.7-50uF/15V 272-1024, 1025 or 1026
 R4 1000 C4 0.22uF/15V 272-1070
 R5 22K
 R6 15K Q1 2N3904 276-1617 (Pkg of 15)
 R7 6800 Q2 MPF102 276-2062
 R8 330 Q3 MPF102 276-2062
 R9 500 ohm pot, up to 2200 ohm ok.
 R10 330
 R11 10Meg
 SW1 ON/OFF, SPST Toggle Switch 275-612, 275-645, 275-634
 SW2 INSIDE/OUTSIDE, SPDT toggle 275-625, 635
 SW3 RESET, SPST Push Button 275-1556
 SW4 BATTERY TEST, SPST Push Button 275-1556
 SW5 Function Select, Meter Switch (STROBE/AMBIENT), DPDT Toggle 5-636, 275-663, 275-626
 Regulator LM317, Adjustable Diffuser/holder for photo cell 272-340.
 Photo Cell CdS or Photo transistor 276-1657 or 276-145

Parts List Figure 12

Strobe/Ambient Light Meter with Digital display
 R1 34.8K* R10 10,000 R19 10K pot
 R2 470KR11 100,000 C1 0.1uF/15V 272-1069
 R3 150KR12 1,000,000 C2 0.1uF/15V 272-1069
 R4 47 R13 22K C3 10-50uF/15V 272-1024, 1026 or 1027
 R5 47 R14 330 C4 0.22uF/15V 272-1070
 R6 10 R15 500 pot, up to 2200 ok.

Figure numbers referenced here are based on Part 1 figures.

R7 10 R16 330 C5 47uF/15V 272-1027
 R8 100 R17 10Meg
 R9 1000 R18 82K Diffuser/holder for photo cell 272-340.
 Photo Cell CdS or Photo transistor 276-1657 or 276-145
 LCD Panel Meter PM-128 (Circuit Specialists 1-800-528-1417)
 Q1 2N3904 276-1617 (Pkg of 15)
 Q2 MPF102 276-2062
 Q3 MPF102 276-2062
 Q4 2N3904 276-1617 (Pkg of 15)
 Q5 TIP32 or similar power transistor
 Q6 2N3904 276-1617 (Pkg of 15)
 SW1 ON/OFF, DPDT Toggle 275-636, 275-663, 275-626 (DPDT, but that is all they list)
 SW2 BATT TEST, SPST Push Button Switch 275-1556 SW4 RESET, SPST P B 275-1556
 SW3 LIGHT LEVEL, 2P 6 position Rotary Switch 275-1386 LED 276-069
 SW5 Function Select, Meter Switch (STROBE/AMBIENT), DPDT Toggle 275-636, 275-663, 275-626
 SW6 AUTO RESET ON/OFF, SPST Toggle Switch 275-612, 275-645, 275-634
 *R1 consists of 10K+18K+6800 connected in series. A 10K resistor plus a 25K pot would work

Parts List, Figure 13

Parts lifted directly from Figure 12.
 Auto-Reset option
 R2 470K Q4 2N3904 276-1617 (Pkg of 15)
 R3 150K Q5 TIP30, TIP32 (900-5168, 900-5170 Tech America)
 R4 47 Q6 2N3904 276-1617 (Pkg of 15)
 R5 47 LED 276-069
 R6 10 SW6 AUTO RESET ON/OFF, SPST Toggle Switch 275-612, 275-645 etc.
 R7 10 C5 47uF/15V 272-1027

Comments

Where to get the parts

As a convenience to those less familiar with this type of equipment, I have broken down the complete systems into smaller, easier-to-build units. That gives us a light meter for ambient-light with analog or with digital display: likewise, strobe-only, with analog or digital display. This way, if you do not want to build a complete, and somewhat more complex system, you may use the parts list for just what you want to build and not have to dig the pieces out of two or three other diagrams.

For the same reason, I have listed some of the part numbers from RadioShack. They are available in many parts of the country. That may save the trouble of getting the parts by mail order. In most cases, you will find equivalent parts from other sources, local distributors or if you have to, via mail-order. If you have to go mail-order, Circuit Specialists and Tech America look like good mail-order stores. Tech America has a wide variety of parts that the serious experimenter should like, and they seem to specialize in making it convenient to do mail-order.

Units with Digital display

The units with digital panel meters need a Double Pole ON/OFF switch. A DP Single Throw switch is ideal, but the RS catalog lists only DP Double Throw (DPDT). You pay a few cents more for the extra contacts, or get the switch somewhere else.

Transistors

The parts lists call for 2N3904s which come in single units, or packages of 10-15, depending upon where you get them. The 2N2222 should work in these instruments. At 10-15 cents each, they look like a good deal, especially since they lend themselves to other projects.

Boxes

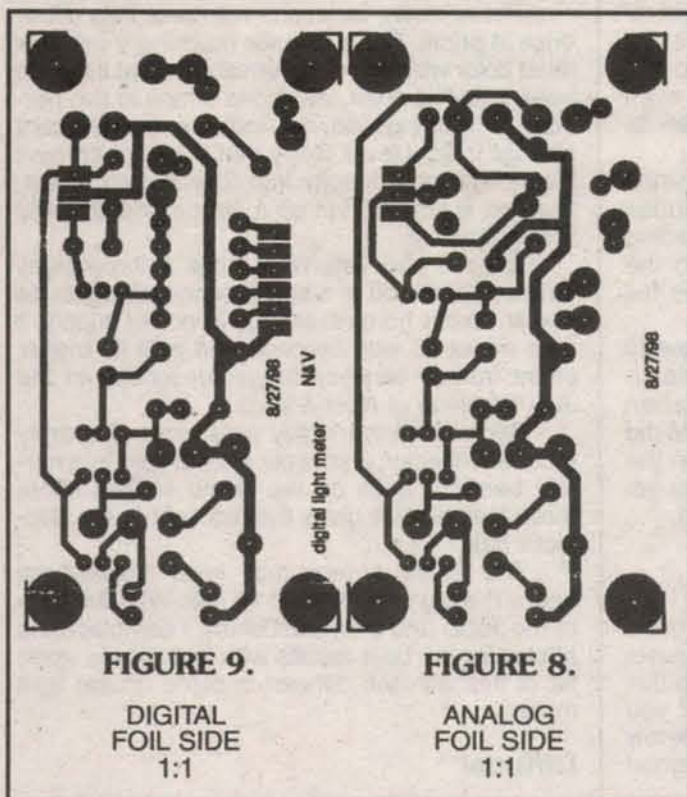
The box for the Digital Light Meter, came from Circuit Specialists. It has a nice appearance, but cost a bit more than the easier to get, 'black box' used for the analog meter. That box came from RadioShack as did the box for the 'Instant' Light Meter, Photo A.

PC Boards

You may get the printed circuit boards for \$4.00 ea., from:

Far Circuits
 18 N. 640 Field Court
 Dundee, IL 60118

Those are the complete strobe/ambient systems, either analog or digital display. Be sure to specify which board you want: digital or analog. These are some of the finest prefab boards that I have seen in years. Fred kindly supplied the layouts if you wish to make your own boards.



if you move around, the readings can change until you hold still. It is that sensitive. Turn the range LIGHT LEVEL switch up a range or two. The numbers should get smaller. On the highest ranges, "5" and HIGH, you will probably want to go outside or point it at a strong light. Outside, this one shows around 400-500 on HIGH and 1,900 to overrange on "5," when looking at a sunlit sky. Calibration will be done later, just check it out now.

To check the STROBE function, set the controls for STROBE, LIGHT LEVEL for "5" or HIGH. Turn it ON or, if it was on, it will probably show some reading. That should stabilize in a second or two. Changing ranges usually puts a reading on the meter.

If the reading drops off, decreases faster than one or two units per minute, go over the section on Board Contamination.

Otherwise, tap the RESET button. After a second or two, the reading should drop down to 000 or maybe as much as 007. If it reads more than that, then hold down the RESET button, or put a clip lead across it and rezero (balance) the FET volt-meter.

Check Photo F for the location of the BALANCE pot, R15 in Figure 6. Set the control for a reading of 000 or as close to that as you can. When done, remove the clip lead. The control should let you move the meter through zero. It should go from plus to minus. Normally the DPMs do not show a polarity sign when reading a positive voltage, but they do display the minus (-) sign when the input goes negative.

Battery Test

If you included the TEST BAT function, this would be a good time to set it. Set the controls

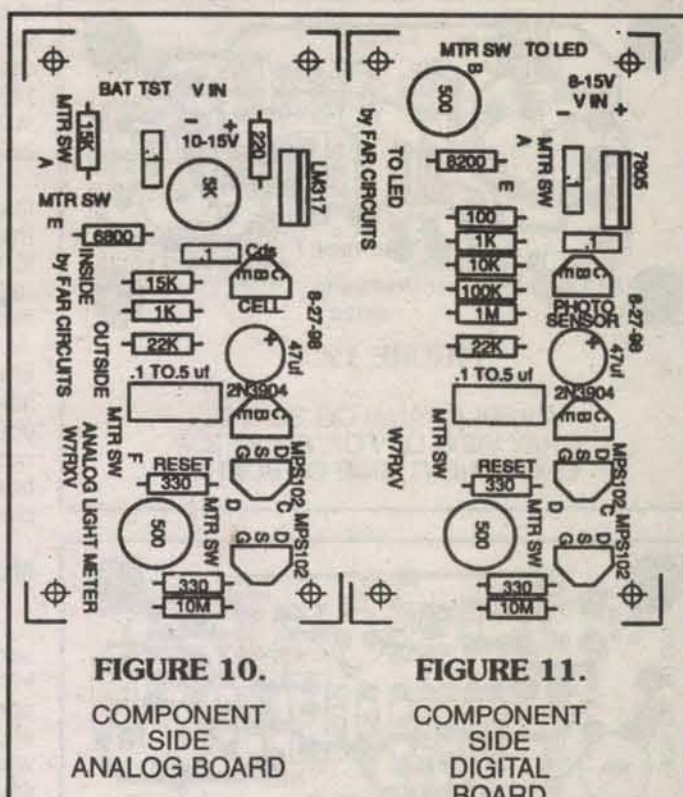


FIGURE 10.

COMPONENT
SIDE
ANALOG BOARD

FIGURE 11.

COMPONENT
SIDE
DIGITAL
BOARD

When you test your unit, If everything seems to work, but the readings from the strobe shots seem to drop off, clean the board. That can happen with either the analog or the digital board. Once you finish the board, lay out the box, and drill the holes for the controls. Mount the controls, then run wires from them to the board, the battery, etc. Before you turn it on, give it one more close look.

Complete Digital Version

As with the analog board, I would recommend putting the resistors on first, then the taller parts. Photo F gives a close-up view of the finished digital board. Lay out the box. Tape a piece of graph paper to the box. Use a pencil to mark the positions for the parts. That makes it easy to 'adjust' the layout. When you like the layout, mill and drill the box. You will probably find it most convenient to put on the labels before mounting the controls and other panel-mount parts. Mount the controls first, mount the digital panel meter last.

Run the wires from the board to the controls and the switches. Make sure that battery plus goes to the correct place, particularly the battery for the digital panel meter. Be sure to follow the instructions that come with your particular DPM.

Check Out Time

When you have everything wired, connect just the battery for the DPM and turn on the power (ON/OFF switch). The meter should show 000. If it does, turn it off and connect the other battery. Set the controls for LOW, AMBIENT, and POWER ON.

The meter should show some numbers, say anywhere from 100 to 1,900, depending upon how much light you have in your work area. After five to six seconds, the reading should stabilize, although

to AMBIENT, LIGHT LEVEL to "4", cover the photo cell. Press the TEST BAT button or put a clip across it. Measure the battery that feeds the main circuit. Adjust the 10 K pot, R19 in Figure 6, so that the DPM gives the same reading as the bench meter did on that battery. Remove the clip from the TEST BAT switch.

I admit that it is a bit crude, but I just could not see taking the thing apart just to check the battery. The AUTO RESET LED will give a bright wink if that battery is up, otherwise the circuit will reset the system but the LED will hardly give a visible light.

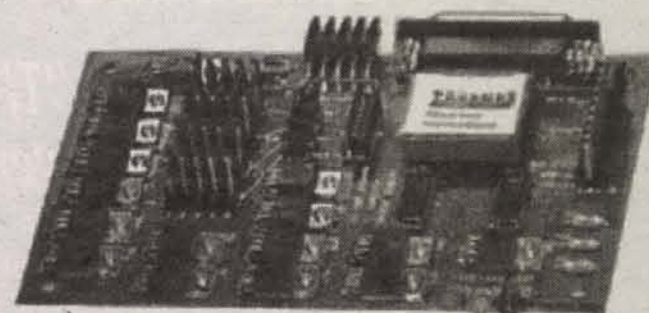
Reset

If you included the AUTO RESET, you may check it now. Get a reading on the meter with the switch in the STROBE position. Turn on the

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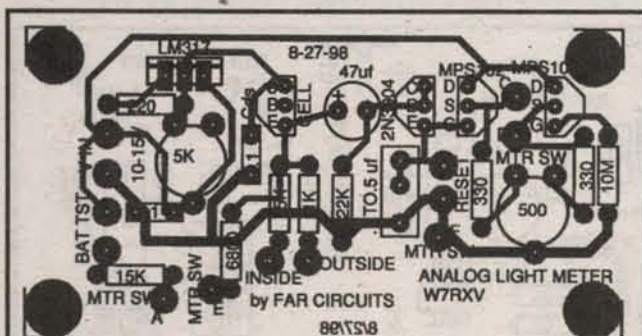


FIGURE 12.

OVERLAY ANALOG BOARD.
X-RAY VIEW OF FOIL FROM TOP
COMPONENT SIDE OF BOARD.

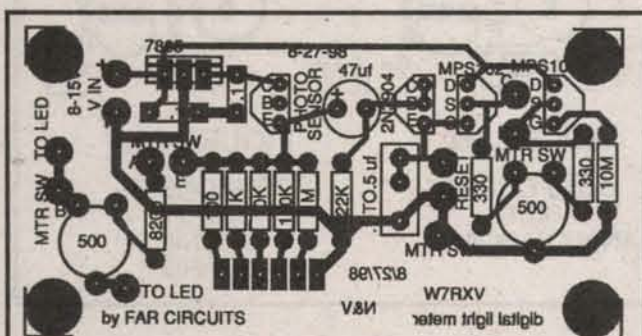


FIGURE 13.

OVERLAY DIGITAL BOARD.

AUTO RESET. After about 15 seconds, the LED should wink and the readout should reset to zero, 000. If it resets but the LED did not seem to wink, wait for it again and try not to blink.

If it looks like the LED does not work, try turning the wires around that go to the LED. If that still does not work, make sure that the battery is up to at least eight volts. As mentioned

earlier, the LED can serve as a form of battery indicator. Although the circuit will still reset the system, the voltage to the LED circuit must be above about eight volts in order to get the LED to give its bright wink.

At first that may seem strange since the AUTO RESET circuit, which includes the LED, has a five-volt regulator feeding it. What it means is the voltage into the regulator has fallen too low to get the full five volts out of it.

Therefore, the main battery needs attention. The battery for the DPM has so little drain on it that you may check it when you replace the main battery. The DPM did not seem to lose accuracy even when the battery for it got so low that the display got dim. Now, let's put the display to work.

Numbers vs. Light, Strobe

While these light meters have good sensitivity, they do not give you light levels in terms of f stops, shutter speed, and film speed. You have to determine that. If you start with a known light source and know what settings you use, that makes a good starting point.

For example, with my favorite strobe and film, I set the camera for f 7 with the strobe 10 feet away from the average subject. See Table II. That means set the lens for f 3.5 at 20 feet or close to f 16 at five feet. With a faster or a slower film, I have to make suitable changes in the f stop setting.

To get a set of numbers that I could relate to camera settings, I set up the strobe, measured the distance to the light meter, and started firing away at it. I took several readings at each distance and averaged them for Table II. They showed minor variations. However, whether the meter showed them or not, they were always there.

Those minor variations will make little difference in prints. The automatic machinery used for most color work will compensate for that if it even sees it. At this point, variations of one to two percent in readings do not indicate a significant change in light level. Sorry that I can not convert these readings directly into footcandles or lux. But that is why we set up a strobe and shoot at the light meter.

Table II also lists what I call a throw-away strobe. It came off of a small camera and gets its power from a home-built plug-in power supply. It runs about 16 watt seconds and gets its trigger pulse from a wireless trigger described in the July '94 issue of *Nuts & Volts*.

Because of the highly polished and sharply focused reflector, it puts out a lot of light in a narrow beam. It goes on top of the subject about three feet away. It gives the highlight to the subject's hair.

The Table shows that level somewhere below the big strobe at 10-12 feet. With the help of the Table and a few test shots, I can place the strobe for the best results with less guess work; all of this with the diffuser in place on the light meter.

Diffuser

The white diffuser screws into the top of the light meter. You want to use it when measuring incoming incident light. Without it, you point the light meter at the subject and measure reflected light. I will let the professional photographers argue over which one they like best, and why.

Without the diffuser, these meters get quite directional. With the diffuser in place, the analog meter reads about 4-5 in an average room. Without it, the meter went from 3-12, depending upon where it was pointed.

Numbers vs. Light, Ambient

This should be easier than you might think. The chart that comes with the film, say ASA 200, tells you that for bright sunlight and average subject, set the camera at 1/200-1/250 and f 16. For close-ups of back-lighted subjects, in shade, set the camera ... Okay, you get the picture. So, take the light meter and see what numbers it gives you in bright sunlight, in the shade, or wherever you may want to take pictures. Those first two settings — bright sunlight and open shade — should be easy to duplicate and make a rather good standard.

Do that and make some test pictures for comparison. That will give you a good idea of how to set the camera when you come across that beautiful meadow or woodland scene that you want to capture on film.

For indoor use, you will have to borrow a standard light meter or make a series of test shots while writing down the readings. Most likely you can draw on past shots to get an idea of where to set the camera until you get the prints or the transparencies back.

After a while, you will develop a series of readings versus lighting conditions that will let you get consistent pictures with the help of one or more of these (more or less) simple, practical light meters. **NV**

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Build a SEPIC Regulator for Your Battery-Powered Digital Project

Portable electronics are everywhere. The trend itself is not new; what is new is the fact that these portable devices are becoming increasingly sophisticated, and many of them are incorporating some sort of microcontroller or other embedded digital circuits. This has been fueled by the increased availability, ease of use, and lower cost of development tools and the microcontrollers themselves.

Perhaps you have got a great idea for such a portable digital project, and you may have started to punch some code. As you debug the code and start laying out the project, a question looms deep in the background: How am I going to power the project? With batteries, of course. Simple question, simple answer, right?

The real answer is that there is more than meets the eye; that portable power is not a trivial consideration.

Beyond Linear Regulators

The old standby for most of the homebrew digital projects has been a 9 to 12 volt "wall-wart" DC supply, followed by a three-terminal linear regulator. The ubiquitous 7805-type regulator is extremely popular for the application. A simple and almost foolproof solution, it only

requires some decoupling caps here and there, and to use your finger as a temperature sensor to determine if a little heatsink is necessary.

The only problem with this scenario: efficiency. Half or more of the total power may be consumed as heat in the regulator. This in itself is no showstopper for a line-powered application. But as every cell phone user knows, high energy storage and utilization efficiencies are paramount to low weight and size while maximizing usage time.

Unfortunately, high energy capacity batteries and their associated chargers are not cheap, and usually beyond the budget of home projects. Thus, the only alternative left is to achieve high regulator efficiency.

High efficiency means, of course, either a low dropout linear or a switch-mode regulator. Low dropout linears are also a simple and attractive solution for many projects. However, battery considerations again may restrict the use of such a device. If our goal is to have simple, low-cost batteries and charging devices (if rechargeable operation is required), then this goal rules out lithium, NiMH, or other state-of-the-art chemistries. For portable devices, nothing beats four "AA" size NiCad or Alkaline batteries. They are affordable and ubiquitous, have an adequate ener-

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Table 1. Typical Power Supply Ratings

Input voltage: 3.9 to 7.0 volt DC @ full load
3.5 to 7.0 volt DC under half load
Output voltage: 5 volt DC, $\pm 5\%$
Operating frequency: 100 KHz nominal.
Load current: 10 to 160 mA continuous rating.
Worst case ripple: 400 mV pk-pk @ full load and minimum input voltage.
Average ripple: 200 mV pk-pk.
Short circuit protection: current limited to ~700 mA.

gy storage capacity for their size and weight, and apparently battery vendors have standardized their retail practices to four-packs. Therefore, four cells should become our portable power target.

Let us analyze the conflict between the proposed four cells and a linear regulator. The end voltage of a depleted cell is about 0.9 to 1.0 volts, depending on the chemistry. On the other hand, most low voltage regulators require at least 0.4 volts above the regulated voltage. This means that to meet the minimum input voltage of 5.4 volts, at least six cells are required. This will not meet our four-cell criteria, and worse, with a fully charged alkaline, 45% of power would be wasted.

Thus, a low dropout regulator is ruled out. This leaves us with switch-mode regulators, of which there are many topologies. Some may be ruled out quite readily; a buck regulator, although simple and efficient, still requires more than four cells. A push-pull regulator is very efficient but complex, and their transformers require to be custom wound and may be too challenging for a novice builder.

The boost topology merits some consideration, as it would allow for even fewer cells. This topology is becoming very attractive for high-end portable devices employing lithium single cell solutions, however, the cost and availability of regulators which may operate in the two to three volt range is still beyond the reach of hobbyists.

The buck-boost would be an ideal candidate: This topology allows the input voltage to be above

or below the output voltage. This is particularly useful in our four-cell target, as the input range will fluctuate from six to below four volts. The fly in the ointment for this topology is that it inverts the polarity of the output voltage; voltages negative to ground are obtained.

Thus, the best solution would be the SEPIC regulator, which also allows input voltages to be above or below the regulated output voltage, while maintaining the polarity. The SEPIC topology provides an additional and very substantial advantage: There is no direct DC path between the input and the output, therefore shorting the output will not cause very high currents to flow, even if the controller IC itself fails. One of the reasons for the SEPIC topology not being very popular is that the feedback loop is more difficult to compensate, but the selected controller IC takes care of it.

Regulator Description

The heart of the switch mode regulator is a LM3578 device, which is part of National Semiconductor's family of Simple Switcher® devices. As its name implies, National has done a superb job of creating a product line which is full-featured, yet simple to use.

The LM3578 is a little more adaptive than other family members which are dedicated to a single topology. The device provides a very novel feedback scheme, which allows simple loop compensation for this topology, which is not particularly easy to stabilize for all voltage input/loading conditions.

This removes one of the

Table 2. Parts List

Designator	Description	Digi-Key p/n
R1a, b	0.33 1/4W 5% 1210 SMT resistor	P0.33SCT
R2	220K 1/8W 5% 1206 SMT resistor	P220KECT
R3	40.2K 1/8W 1% 1206 SMT resistor	P40.2KFCT
R4	10.0K 1/8W 1% 1206 SMT resistor	P10.0KFCT
R5	31.6K 1/8W 1% 1206 SMT resistor	P31.6KFCT
C1	2200 pF 10%, 1206 SMT ceramic capacitor	PCC222BCT
C2	20 pF 5%, 1206 SMT ceramic capacitor	PCC200CCT
C3	2200 pF 10%, 1206 SMT ceramic capacitor	PCC222BCT
C4	4.7 uF, 6.3V, size A Tantalum capacitor	PCS1475CT
C5a, b	4.7 uF, 6.3V, size A Tantalum capacitor	PCS1475CT
C6a, b	4.7 uF, 6.3V, size A Tantalum capacitor	PCS1475CT
L1	150 uH inductor Miniature Hi Current	M5820
L2	100 uH inductor Miniature Hi Current	M5818
D1	1N5817 Schottky diode	1N5817CT
IC1	LM3578 switch-mode controller, 8-DIP	LM3578AN

Miscellaneous Parts:

Four-cell AA battery holder, SPST switch, hookup wire, ferrite beads.
Contact the author at HYPERLINK E-Mail: garciaviesca@worldnet.att.net for board availability.

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STOCK#	1-9	10-24	25+
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SINGLE TURN TRIMPOT



- 1/2 Watt
- 10% Tolerance
- 3/8" Square
- TO-5 Grid
- Top Adjustment
- Bourns 3386P or equal

STOCK#	DESCRIPTION	1-24	25-99	100+
PO150	50 ?	.59	.56	.50
PO1100	100 ?	.59	.56	.50
PO1500	500 ?	.59	.56	.50
PO11K	1K ?	.59	.56	.50
PO12K	2K ?	.59	.56	.50
PO15K	5K ?	.59	.56	.50
PO110K	10K ?	.59	.56	.50
PO120K	20K ?	.59	.56	.50
PO150K	50K ?	.59	.56	.50
PO1100K	100K ?	.59	.56	.50
PO1200K	200K ?	.59	.56	.50
PO1500K	500K ?	.59	.56	.50
PO11M	1 Meg ?	.59	.56	.50

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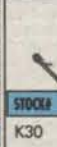


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


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


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- TO-220 type
- .75" square x .375" high

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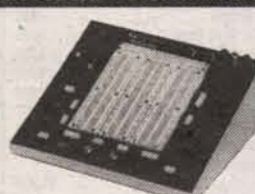
11 piece kit containing:

- 3/16" & 1/4" nut driver
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- Tweezer
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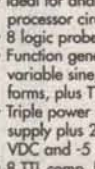


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SW6S	6 Position	.59	.56	.50
SW7S	7 Position	.59	.56	.50
SW8S	8 Position	.59	.56	.50
SW10S	10 Position	.69	.66	.59
SW12S	12 Position	.69	.66	.59

STOCK#	DESCRIPTION	1-24	25-99	100+
SW4S	4 Position	.59	.56	.50
SW5S	5 Position	.59	.56	.50
SW6S	6 Position	.59	.56	.50
SW7S	7 Position	.59	.56	.50
SW8S	8 Position	.59	.56	.50
SW10S	10 Position	.69	.66	.59
SW12S	12 Position	.69	.66	.59

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CORCARA	.19	.18	.16

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- Solder tail
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STOCK#	1-24	25-99	100+
SW1004	.39	.37	.33

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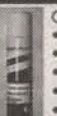


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
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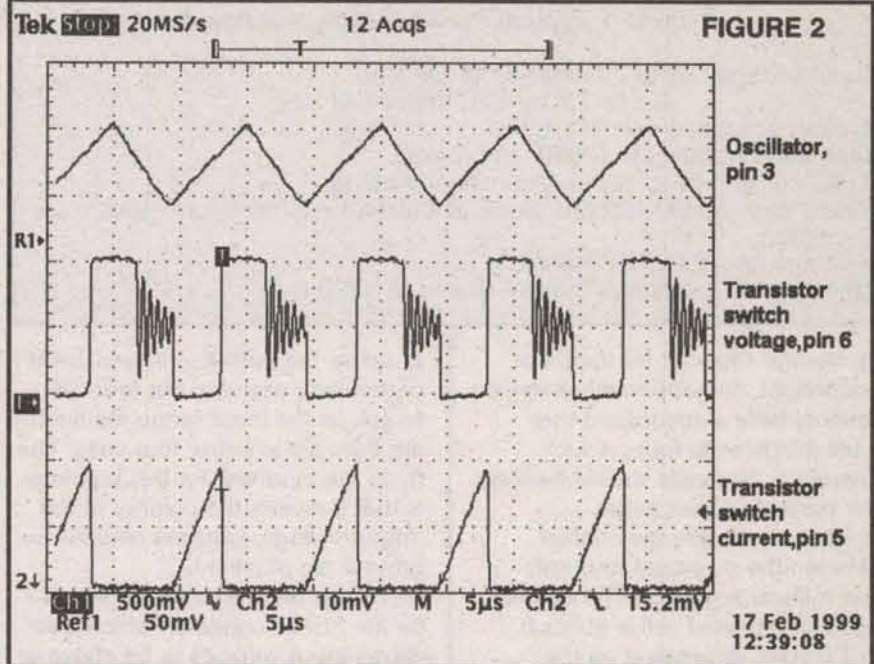
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HP 54200A, Digital Storage Scope	\$800	Wavetek 185, Sweep Function Gen. .0001-5MHz	\$400
HP 6112A, Power Supply, 0-40V, 0.5A	\$200	Wavetek 186, 5MHz Phase Lock Generator	\$200
HP 8015A, Pulse Generator, 1Hz-50MHz, 30V	\$500	Wavetek 1084, Signal Gen. Sweeper, 3.5-4.5GHz	\$300
HP 8165A, Programmable Signal Source, .0001-50MHz	\$1,000	Wavetek 1910, XY Monitor, Dual Trace	\$400
HP 8165A, Programmable Signal Source, Opt. 02/03	\$1,200	Wavetek 452, Filter, Dual Hi/Low, 1Hz-10KHz	\$450
HP 8350B, Sweep Oscillator Mainframe	\$2,000	Wavetek 7530A, FFT Spectrum Analyzer 0-100KHz	\$500
HP 83540A, RF Plug-In, 2-8.4GHz	\$1,200	Wavetek 907, Signal Generator, 7-11GHz	\$600
HP 83545A, RF Plug-In, 5.9-12.4GHz	\$1,200	Wavetek 955, Micro Source, 7.5-12.4GHz, AM, FM, Sweep	\$1,000
HP 83592C, RF Plug-In, 0.1-20GHz	\$8,000	Wiltron 560A, Network Analyzer	\$800
HP 8410C/8412B, Network Analyzer	\$800	Wiltron 560-7K50, RF Detector, 10MHz-40GHz	\$400
HP 8411A, Frequency Converters	\$250	Wiltron 560-97A50, SWR Autotester, 0.1-18GHz	\$500
HP 8414A, Polar Display	\$300	Wiltron 610D, Sweeper Mainframe	\$250
HP 8445B, Spectrum Anyz., Automatic Pre-Selector	\$300	Wiltron 610D/6237D, Sweep Generator, 2-18GHz	\$800
HP 8505A, Network Anyz. w/8501A & 8503A, Opt. 05	\$4,000	Wiltron 6213D, RF Plug-In, 10MHz-4.2GHz	\$400
HP 85021B, Directional Bridge, 10MHz-26.5GHz	\$1,200	Wiltron 6219D, RF Plug-In, 2-8GHz	\$200
HP 85027B, Directional Bridge, 10MHz-26.5GHz	\$1,200	Wiltron 6223D, RF Plug-In, 4-12.4GHz	\$250
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HP 8559A/853A, Spectrum Analyzer, Digital, .01-21GHz	\$3,500	Wiltron 6647A-20/02/03, Programmable Sweep Generator	\$4,000
HP 8565A, Spectrum Analyzer, 0.1-22GHz	\$3,500	Wiltron 6NF50, Autotester, 1-1500MHz, for 640	\$100
HP 8565A, Spectrum Analyzer, 0.1-22GHz, Opt. 100	\$4,000	Wiltron 7B50, Detector, 1-1500MHz, for 640	\$100
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HP 86241A, RF Plug-In, 3.2-6.5GHz	\$400		
HP 86260A, RF Plug-In, 12.4-18GHz	\$400		
HP 86290A, RF Plug-In, 2-18GHz	\$1,200		
HP 86290B, RF Plug-In, 2-18GHz	\$1,400		
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HP 8656B, Signal Generator, 1-990MHz, AM/FM	\$2,000		
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Relevant waveforms at five-volt DC input and a load of 65 mA. These waveforms may change with different input voltages and/or load currents.

SEPIC's drawbacks. It also allows the frequency to be determined by an external capacitor, which is very useful in this project since the SEPIC topology requires two inductors, and choosing the highest allowable frequency will minimize their size. Provision for setting the current limit is performed by an external resistor.

Figure 1 shows the complete schematic of the supply. Attached to U1's pin 4, C1 is the timing capacitor, which sets the internal oscillator to run around 100 KHz, which clocks the pulse width modulator. This, in turn, drives the output transistor. In this topology, the transistor's collector switches to ground the node at L1 and C5, simultaneously allowing current to build up at L1 and for capacitor C5 to pump current into L2, with the charge previously stored at C5.

At this point of time, D1 is reverse biased, and the charge stored at C6 supplies current to the load. During the next phase, the transistor releases the node, and the current stored in L1 both recharges C5 and flows into diode D1, which becomes forward biased.

At the same time, the current stored in L2 starts flowing into the diode. The sum of both L1 and L2 currents supplies the load and replenishes the charge on filter capacitor C6. The cycle then repeats itself. Figure 2 shows some relevant scope waveforms.

Feedback stability compensation is achieved with R2, C2, and C3. Resistor R1 sets the transistor's current limit, and R4 provides feed-forward compensation for varying battery voltages.

You may have asked yourself by now how come R1, C5, and C6 are implemented with two paralleled devices instead of using a single device of the appropriate value. The reason is that through these components a fairly high current at high

frequency passes; to maximize efficiency, it is good practice to parallel devices, as it will reduce parasitic losses. Besides, the devices employed are surface mount, which usually come in multiples of 5 or 10 pieces.

Rather than discard the unused parts, it is better to employ them. Typical performance is summarized in Table 1. Since this is a hobbyist circuit and cannot control the assembly methods or the components used, the circuit performance is not guaranteed and should be taken as reference only.

Building the Circuit

As this project is intended for portable devices, compact size and low weight are important considerations. To meet these considerations, while reducing interference emissions and maximizing efficiency, surface mount components are strongly suggested. SMD's leadless components behave extremely well at high frequencies. And, to effectively use SMD components, a printed circuit board should be employed, as shown in Figure 3.

Some leaded components are also utilized in this project. The board is a mere 1.95" x 1.50" and is half the height of a battery pack, so it should fit comfortably in any handheld enclosure. A parts list is shown in Table 2.

Don't despair if you have not assembled SMD devices before. For ease of assembly, the SMD components chosen for the board are the largest available — the 1206 size. You'll have to solder them first before assembling the leaded components.

SMD assembly requires a fine point, low wattage iron, tweezers, and fine 63/37 solder. A small magnifying glass to check solder quality is very helpful. Assembling SMD devices presents some challenge

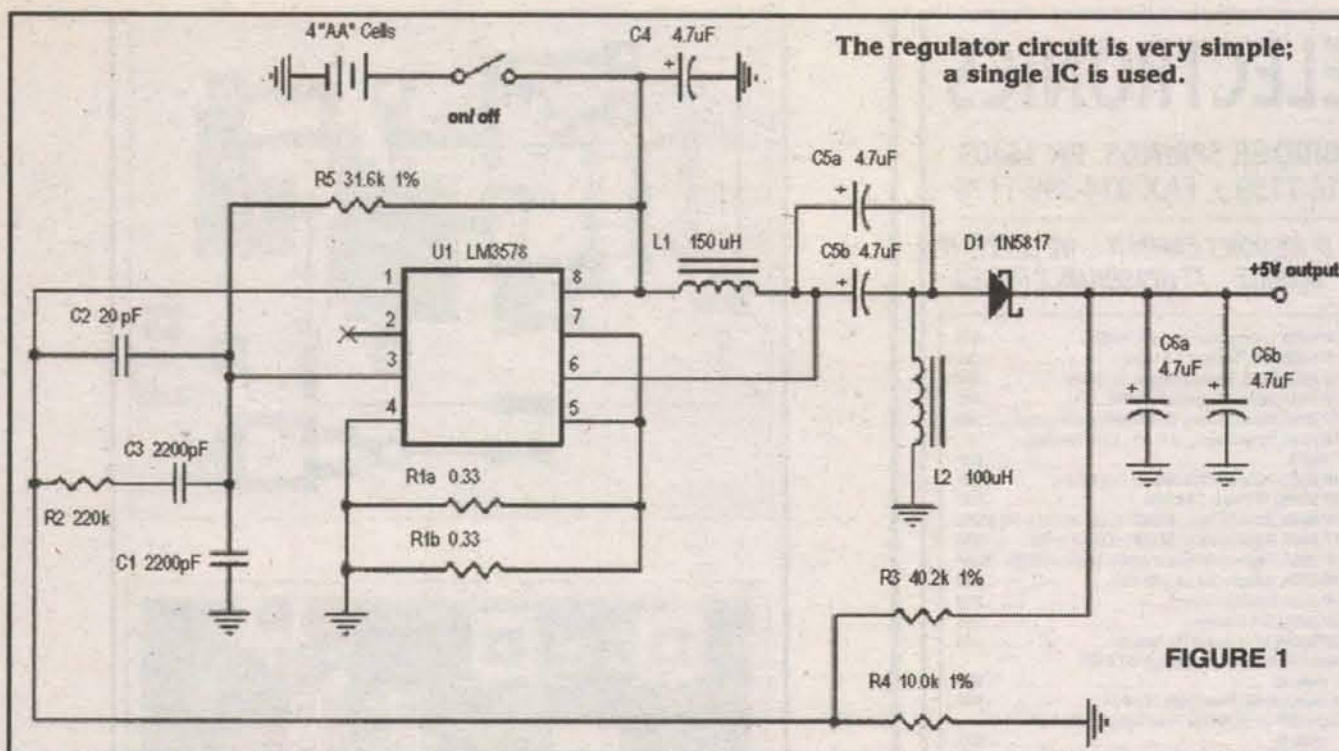


FIGURE 1

since they are not mechanically secure to the board as you try to solder them.

An easy way to solder them to the board is a three-step process: First, slightly wick with solder just one of the board pads and, while keeping the pad warm with the iron, attach the component. The component is secured now to the board, which frees one hand. Second, you solder the opposite side of the component. Lastly, you come back to

the first side — which may have a poor solder joint — to retouch it and to achieve a bright nice solder.

Tantalum capacitor polarity is particularly important, and it is marked with "+" signs on the board.

Leaded components are assembled next. Although the board has plated thru holes, for good assembly practice ensure that the devices are soldered to the component (top) side, as all signals run there. This recommendation extends to

the IC pads. You may need to retouch a few pads. The bottom layer is mostly used as a ground plane. The diode's polarity is marked with an arrow. The battery pack and the on/off switch are assembled outside the board.

After doublechecking your assembly, it is time to test the circuit prior to hooking it up to a digital circuit. Switch-mode power supplies always require a load to function properly so, for testing purposes,

attach a 68-ohm, one-watt resistor to the output. Power-up the supply using fresh alkaline or fully charged NiCad batteries. With a voltmeter, ensure that the output voltage is correct. Now you are ready to hook up a real load.

A note about switch-mode regulators: they produce high frequency ripple on the output. The capacitor values as shown in the schematic will produce about 400 mV ripple worst case, with full load and minimum input voltage. Supplemental capacitance may be added to the regulator or at the point of load to reduce ripple. The latter solution is preferable, as it will also provide some necessary decoupling to the load.

Although this project does not produce excessive EMI due to the tight layout and generous ground plane, if interference is detected, just slip a ferrite bead through both the output leads. And a last recommendation: Always doublecheck that batteries have not been installed backwards.

To avoid efficiency penalties due to the voltage drop of a series diode, reverse polarity protection has not been provided in this project. If you determine that the feature is essential, employ only a Schottky diode as it provides a lower forward voltage drop. **NV**

See PCB patterns on page 70.

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Fluke 8050A, DMM 4-1/2 Digit w/o Battery Pack.....	\$145
Fluke 8520A, DMM 5-1/2 Digit.....	\$275
Fluke 8800A, DMM 4-1/2 Digit w/o Battery Pack.....	\$100
Fluke 8800A, DMM 5-1/2 Digit.....	\$125
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HP 204C, Oscillator, 5Hz-1.2MHz, 5VRMS.....	\$125
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HP 339A, Distortion Analyzer w/Low Distortion Oscillator.....	\$950
HP 350D, Attenuator.....	\$75
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HP 400FL, RMS Voltmeter, 20Hz-4MHz, 100uV-300V.....	\$175
HP 415E, SWR Meter.....	\$100
HP 4276A, LCZ Meter.....	\$1,700
HP 432A, Power Meter w/Cable/47dB, .01-18GHz Sensor.....	\$350
HP 432A, Power Meter w/o Cable/Sensor.....	\$150
HP 435A, Power Meter w/o Sensor/Cable.....	\$100
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HP 654A, Oscillator, 10Hz-10MHz, 90dB Attenuator.....	\$195
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Tek 7603, Scope Mainframe (100MHz).....	\$150
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Wavelek FG3B, Sweep/Function Generator 2Hz-100KHz (unused).....	\$200

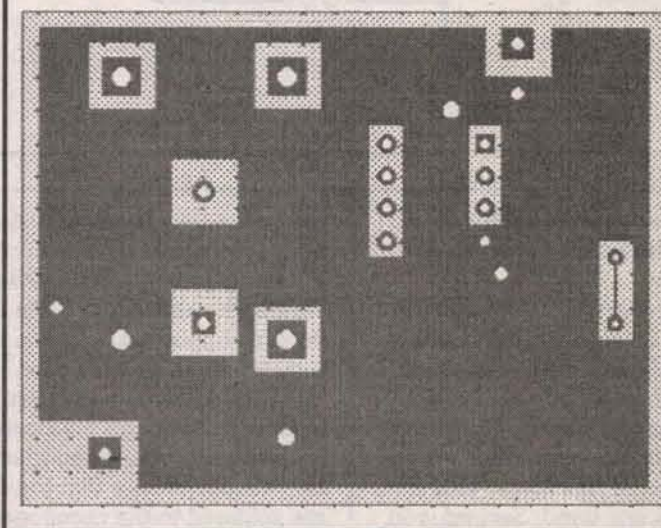
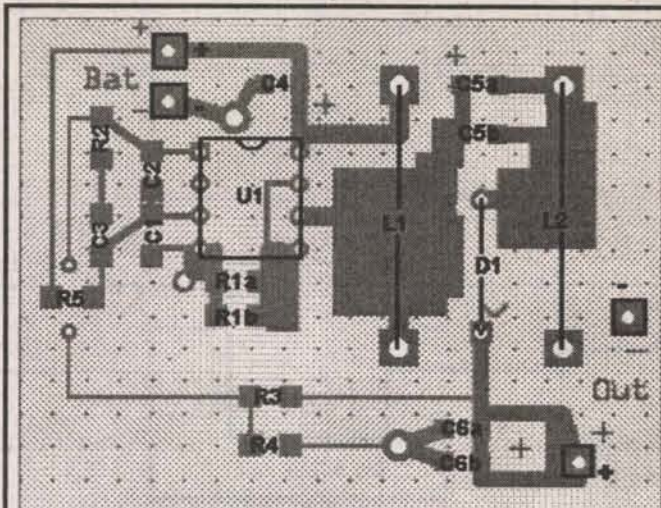
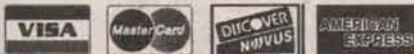
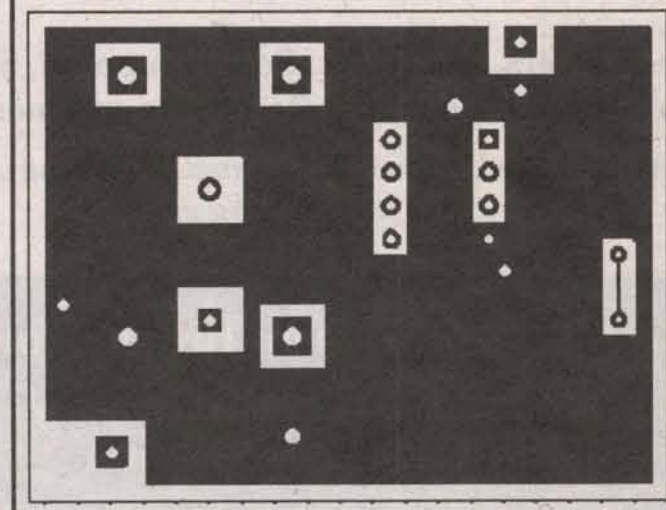
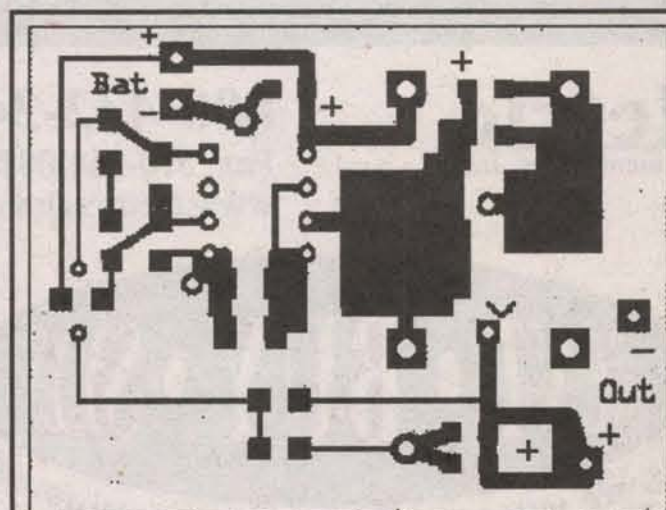


FIGURE 3. Suggested board layout. Components and most of the traces go on the top layer, the bottom layer is used mostly as ground plane.



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TECH FORUM

Continued from page 55

ANSWER TO #29910 - FEB. 1999

Part 1: A quick and expensive solution would be to check AVTinc at www2.ari.net/avt-inc/. They have OBDII related adaptors for desktops and portable computers.

Look for a 19-pin D-type connector under the area of the steering wheel, under the dash if you see it, then your vehicle OBDII compatible. Once you have the software and hardware, you will be able to

read/erase fault codes and get a live sensor and actuator data with the engine running.

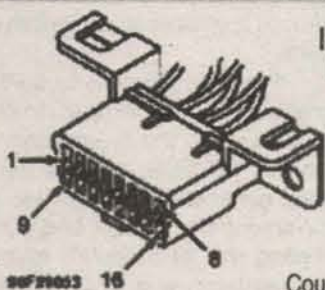
On vehicles with automatic transmissions, the same computer also runs the transmission such as Fords E4OD or GMs 4L80E that are used in the pickup trucks. Some Chrysler/Dodge products use a separate computer to run the transmission.

Part 2: If you are going to do it

yourself, you would still need the diagnostic equipment, plus another computer to watch the serial data and record the commands that are used to activate the vehicle's computer to send the fault codes or to send the live data from the sensors and actuators. Either way, it's going to be expensive.

Dan Hockey
via Internet

Identifying Data Link Terminals



Courtesy of Chrysler Corp.

DATA LINK CONNECTOR TERMINAL IDENTIFICATION

Terminal	Wire Color	Function
3	Violet/Brown	CCD Bus (+)
4	Black/Light Green	Ground
5	Black/White	Ground
6	Light Green	SCI Receive
7	Pink	SCI Transmit
11	White/Black	CCD Bus(-)
14	Pink/Light Blue	BCI Receive (TCM)
16	Pink	Fused B+

ANSWERS TO #2994 - FEB. 1999

The ZN414 and ZN416 are obsolete, so buy them while you can.

They have been available recently from Nuts & Volts advertiser Halted Specialties:

Halted Specialties Co.

3500 Ryder St.

Santa Clara, CA 95051

408-732-1573

1-800-442-5833 orders

<http://www.halted.com/>

They also have a Sacramento location.

If Halted runs out, Oatley Electronics (Australia) sells an MK484 part which they claim is the same as a ZN414:

Oatley Electronics

P.O. Box 89

Oatley NSW 2223

Australia

oatley@world.net

Phone: +61-2-9584-3563

Fax: +61-2-9584-3561

<http://www.oatleyelectronics.com/>

David DiGiacomo
San Francisco, CA

ANSWERS TO #2994 - FEB. 1999

AM radio receiver chips ZN414 are available from Ocean State Electronics, 1-800-866-6626 for \$7.95.

They also carry FM Receiver ICs TDA7000 for \$9.95, and Signetics NE602AN mixer-oscillator for superhet receivers and ferrite antennas. Look at their ad in *Nuts & Volts Magazine* in the Feb. '99 on page 42.

Joe Kish
Clackamas, OR

[orders] or at 513-531-4499 (information).

Brian Piller
Baxter Springs, KS

ANSWERS TO #39912 - MAR. 1999

Although you could design and construct a suitable voltage step-up circuit (Maxim sells several DC-DC step-up controller ICs), it would be much easier to purchase a 12VDC to 115VAC inverter at one of the discount stores.

These are small electronic products that plug into the car's cigarette lighter and provide 115V/60 Hz main power for PCs, TVs, VCRs, or whatever. Be sure to get one that has a wattage rating that exceeds your worst case

load.

On a trip to Walmart, I found a 140-watt unit (more than enough power for a typical laptop PC) for \$39.00, but if you watch for a sale you can get low wattage units for as little as \$25.00.

Thomas Black
Folsom, CA

ANSWERS TO #39912 - MAR. 1999

Probably the safest way to secure 18 volt DC for your computer would be to purchase three small to mid-size six-volt lead-acid batteries from a supplier such as H&R, 1-800-848-8001 which start at \$8.00 each for the four-amp hour lead-acid

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\$75.00

MILLIOMETER

HEWLETT PACKARD, Model 4328A. Designed to measure very low resistances. Measurement range 1m ohm to 100 ohms. Resolution 20 u ohms. Analog meter readout. Ideal for measuring contact resistance of switches or relays. This unit is also useful for measuring the resistivity of semiconductor devices. (Requires special 4 terminal probes which are not supplied, but probably are available from Hewlett Packard.) Power input: 115-230 VAC 48-66 Hz, 5 VA max. Dimensions: 5-1/8" wide x 11-1/2" deep x 6-1/2" high.

Stock #TE9812

\$200.00

200,000 COUNT DIGITAL MULTIMETER, FLUKE, Model 8800A.

LED readout. 6-digit, auto-ranging multimeter. Basic accuracy $\pm 0.05\%$. 15 ranges DC volts: ± 200 mV to ± 1200 V in 5 ranges accuracy $\pm 0.08\%$ or better. AC volts: 2 VAC to 1200 VAC in 4 ranges. Accuracy $\pm 1\%$ or better depending on frequency and range. Resistance 200 ohm to 20 meg ohms in 6 ranges. Accuracy $\pm 0.2\%$ or better. Input impedance: 1000 meg ohms or more on DC ranges, 2 meg ohms on AC ranges. Has complete overload protection and isolated inputs. Power input 110/230 VAC 50/60 Hz 8 watts. Built-in carrying handle that also acts as a tilt-up base. Dimensions: 3-1/2" high x 9" wide x 12-1/2" deep.

Stock #TE9815

\$100.00

3600 RPM DC MOTOR WITH OPTICAL ENCODER PACIFIC SCIENTIFIC, #4VM82-004-4. 30 volts nom. input voltage. Permanent magnet, reversible servo motor. Has Hewlett Packard optical encoder. Ball bearings. No load speed at 30 VDC input is 4600 rpm. No load current 0.75 amp at 60 oz-in load rpm is 3600, current is approx. 6.6 amps. Torque constant is 9.1 oz-in per amp. Rotor inertia 0.0007 oz-in-sec². Terminal resistance 0.89 ohm. Optical encoder is similar to "HEDS 6000" series. Encoder has 1024 counts per revolution, two channel quadrature output. Outputs are TTL compatible. Encoder requires 5 VDC input at less than 50 mA input current. Dual shafts: front shaft is 3/8" dia. x 3/4" long. This shaft is tapped on the end 8X32 tpi. Rear shaft is 1/4" dia. x 7/16" long. This shaft has dual flats that measure approx 3/16" across. Motor has four 8X32 tpi tapped mounting holes on front. A 3-3/16" dia. centering pilot is also provided on the front face. Dimensions: 4" dia. x 5-1/2" long (excluding shafts.)

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TECH FORUM

battery and \$20.00 for the 10-amp battery.

You can charge these batteries individually from your generator, and then connect them in series for your computer. Using this method over the DC to DC converter means that there is a zero power loss due to switching or resistance, with a 99.99% safety factor over voltage fluctuations or parts failure.

The battery is a tried and true method of accomplishing a stable

platform for power especially if every watt is important to you due to your remote living status. Even the best DC to DC converter will waste some power in switching no matter how efficient they have become.

Ni-Cds can also be used and placed in a series/parallel configuration to accomplish both the current and voltage requirements that you seek, but they generally cost more.

Chris
Bieber, CA

ANSWERS TO #2991 - FEB. 1999

These garage door obstacle detectors typically use an infrared LED light source in the transmitter with a matched infrared receiver. The most effective arrangement (used in TV and VCR remotes) pulses the IR LED at around 40KHz. This helps to avoid interference from ambient light sources.

Several manufacturers make small receiver modules for around \$3.00 which are tuned to accept 40KHz pulsed IR signals, and reject other light sources. They typically run from a 5V supply, and have three pins: +5V, signal, and ground.

One such receiver is the GP1U52X, which is manufactured by Sharp, and is also sold by RadioShack as part #276-0137 or #276-137B. You can find a copy of the data sheet at http://support.tandy.com/support_supplies/17533.htm.

If you want to build transmitter and receiver circuits using this module, there is a lot of information available on the Internet. See <http://www.seattlerobotics.org/>

guide/infrared.html for an example of both transmitter and receiver circuits.

If you have access to a PIC programmer, a very simple circuit can be built using the inexpensive eight-pin PIC 12C508, which is used for both generating the 40KHz signal for driving the IR LED, and for interpreting the IR module's output on the receiving end to detect a valid signal.

A circuit schematic, PCB layout, and PIC source code can be found on the Internet at <http://www.verinet.com/~dlc/projects/botproj.htm>

Note that the circuit described above was originally intended for use as an obstacle detection device for a mobile robot, with both the IR LED and the IR detector module mounted to the PCB.

For your application, you should be able to simply attach the IR LED to the end of a two-wire cable, rather than to the PCB.

For the resistor which is in series with the IR LED, I would try experimenting with different values until you get the desired range.

Regardless of the circuit you choose, if you intend to use this outdoors you will want to ensure that you protect the IR receiver from ambient sunlight as much as possible, since sunlight contains enough IR energy to swamp the receiver, making the IR light coming from the LED virtually indistinguishable.

Under these conditions, you should consider shielding the receiver with a black tube that is opaque to IR light, and placing the LED emitter in such a way as to point into the open end of the tube. It also helps if this tube is threaded on the inside to reduce the amount of ambient light that is able reflect off the inside of the tube and make its way to the receiver. Placing lenses in front of the LED and/or receiver may also help.

For further background information on IR transmitters and receivers, check out <http://www.wirz.com/tutorial/IR/index.html>.

Another good source for IR circuits, in general, is <http://godot.tuniv.szczecin.pl/~mjaskula/tomi/opto.html>.

Mark Winters
Orem, UT

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TECH FORUM

ANSWERS TO #2991 - FEB. 1999

A beam breaking alarm can be fairly easily made with an Infrared (IR) receiver/demodulator module as used for IR remote controls. RadioShack sells an IR receiver module #276-137. It includes an application note with a circuit which will function just as you have described.

I have, in fact, built a garage door entrance alarm using a slightly modified version of this circuit. Referring to the figure, for continuous operation remove S1 and short the connections to it.

A +5 VDC power supply can be substituted for Bt 1, so the transmitter and receiver circuitry can use the same power source. If 5V is used, R1 should be changed from 150 to

50 ohms. The output of the LM567 tone decoder is an open collector (pin 8) and is turned on when the receiver is detecting the modulated IR beam from the transmitter. This means that the output goes high when the beam is broken.

A 4.7K resistor can be substituted for R2, LED 2 if a TTL compatible signal is desired from the tone decoder. Two IR LEDs can be connected in series (R1 is changed to 10 ohms) to get a wider beam pattern and more range between the transmitter and receiver.

In my application, the transmitter and receiver are separated by 20 feet!

Kevin Goodwin
Oceanside, CA

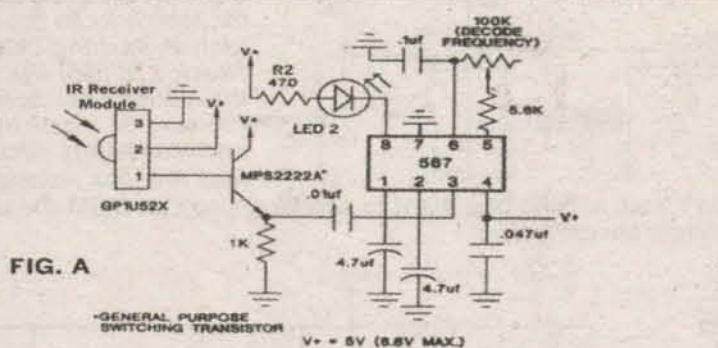
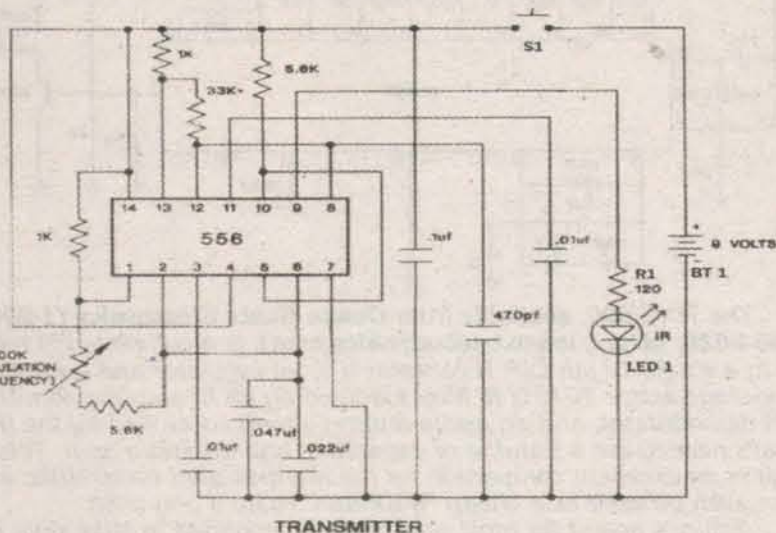


FIG. A

*GENERAL PURPOSE SWITCHING TRANSISTOR
V+ = 5V (6.8V MAX.)

RECEIVER



TRANSMITTER

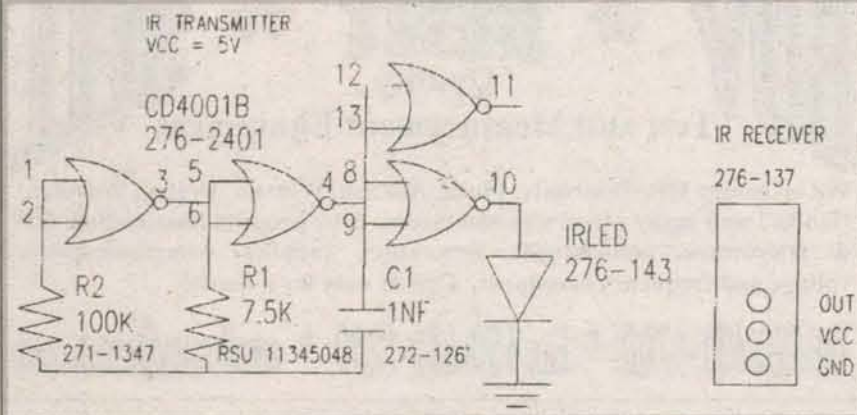
*Ground Pin 6 and adjust to 40kHz +/- 2 kHz from pin 9 with parallel/series resistance

ANSWERS TO #2991 - FEB. 1999

I have used this circuit in a stop watch for the Pinewood Derby, I think it will meet your needs. The parts are all available from RadioShack.

If you need a switch closure, put a buffer and relay at the IR receiver output.

Russell Kincaid
Milford, NH



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SILRX — \$26.00 ea.
TXM — \$15.50 ea.

The TXM and SILRX modules are a transmitter and receiver pair which can achieve a one-way radio data link-up to a distance of 200m over open ground.

Both units are supplied in space-saving single in-line packages and offer SAW controlled, wide band FM transmission/reception.

The modules are particularly suited to battery-powered, portable applications where low power and small size are critical design criteria.



TX2/RX2

TX2 — \$19.50 ea.
RX2 — \$38.50 ea.

The TX2 and RX2 radio transmitter and receiver pair enable the simple implementation of a data link at up to 40kbit/s at distances up to 75m in-building and 300m open ground. Both modules combine full screening with extensive internal filtering to ensure EMC compliance by minimizing spurious radiations and susceptibilities. The TX2 and RX2 modules will suit one-to-one and multi-node wireless links in applications including car and building security, EPOS and inventory tracking, remote industrial process monitoring, and computer networking.

Because of their small size and low power requirements, both modules are ideal for use in portable, battery-powered applications such as hand-held terminals.



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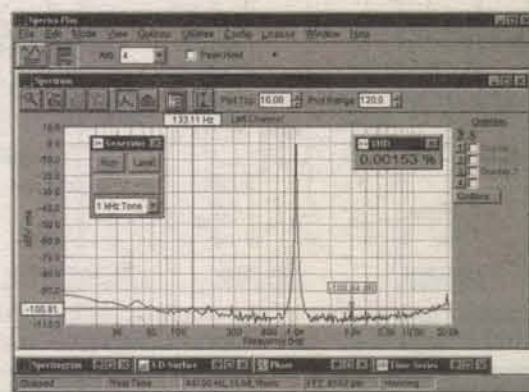
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Applications

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System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
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Nuts & Volts Magazine/April 1999

73

Q & A

• • • • • With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me at TJBYSERS@aol.com, TJBYSERS@juno.com or by snail mail at Nuts & Volts Magazine, 430 Princland Ct., Corona, CA 91719.

What's Up: Plenty of projects: FM transmitter with latching receiver for alarm applications, a 30-minute watchdog timer, battery-operated phone ring tester, and battery-powered event sequencer. More on hard-to-find parts and schematics, including video game schematics and pinouts. Reader feedback on propane generators.

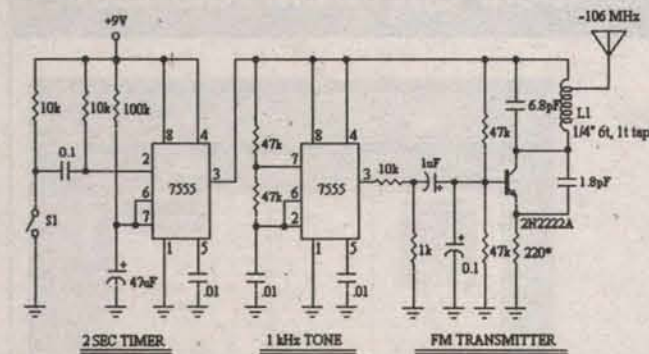
Mailbox Monitor

Q. Do you know of anyone who builds a device that announces when the mail person has delivered, something similar to Kenton Chun's "Electronic Mail Is In-Dicator" that appeared in the Jan. '98 issue? It's for my Grandpa, who is 84 years old. Every day he walks to the mailbox, nearly 1,000 feet from the house, to check the mail — often more than once. I know the walk is good for him, but after four trips (when the mail is late) he grows weary. Grandpa and I are both experienced ham operators, and neither believe a doorbell transmitter like that described in the Jan. '98 issue can span this distance. Do you have a better solution? (P.S. I'd like to make it for him in time for Christmas, as a present.)

Mike Kirby KB7QWA
via Internet

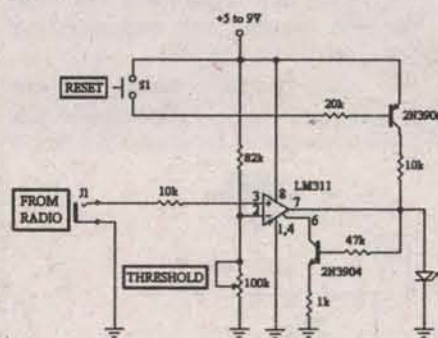
A. I know for a fact that the wireless doorbell chime won't cut it. I have one, and the signal grows weaker with each passing day – it's down to 30 feet now! I know you're under a time crunch, so I didn't have time to test the circuit below. Given the fact that you're a ham, I trust you can cut and try this transmitter without too much trouble.

It's an FM transmitter that should span the 1,000-foot distance; if not, reduce the 220-ohm resistor to 100 ohms to increase the output power. The antenna is a two-foot hank of insulated wire. S1 is a mercury switch



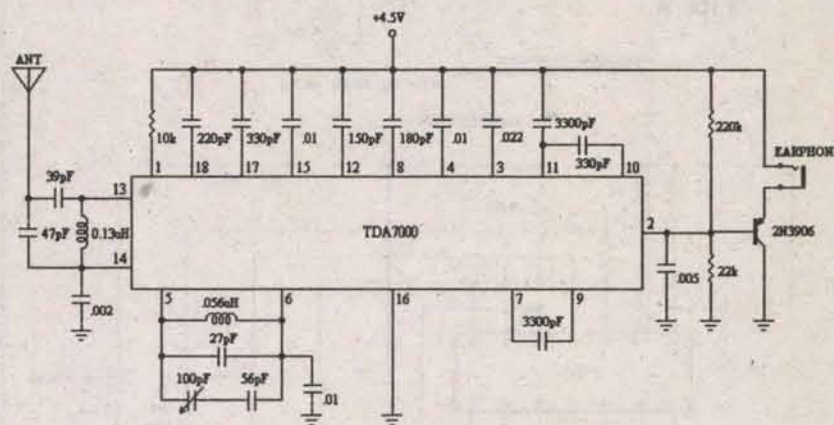
attached to the door of the mailbox. When the door is opened, the switch triggers the two-second timer, which applies power to the

audio and RF oscillators. (The first IC prevents the transmitter from continually sending should the mail carrier leave the door open.) The receiver can be any FM radio tuned to about 106 MHz. You can fine-tune the transmitter's frequency by expanding or compressing the windings of L1. If you're not in the room when the alarm goes off, though, you won't hear the beep. The solution is to add a latching indicator to the receiver. Simply plug the indicator circuit below into the earphone outlet, and adjust the volume control so it responds to the mail only, and not static. If you have a mute/squelch switch, turn it on.



The latch is a simple LM311 comparator with a strobe input. When the comparator output goes high, indicating an alarm tone, it turns on the 2N3904 transistor, which locks the output high. A flashing LED (Radio Shack 276-036) lets you know the mailbox has been opened. Pressing S1 resets the LED and readies the circuit for the next mailbox invasion. If you

don't have a radio you want to sacrifice, you can build the simple FM receiver shown below.



The TDA7000, available from **Ocean State Electronics (1-800-866-6626; <http://www.oselectronics.com>)**, is a complete FM receiver in a single 18-pin DIP. It contains a local oscillator and a mixer, a two-stage active 70-KHz IF filter followed by an IF amplifier/limiter, an FM demodulator, and an audio muting circuit controlled by the IF. All that's needed are a handful of capacitors and an audio amp. This circuit is an excellent companion for the mailbox alert transmitter, and can even be used as a cheap "Walkman" radio if you wish.

(Editor's note: Like most questions, I responded to Mike's via E-Mail. A few days later he mailed back to say that the transmitter works just fine, and that he had it working in time for Christmas.)

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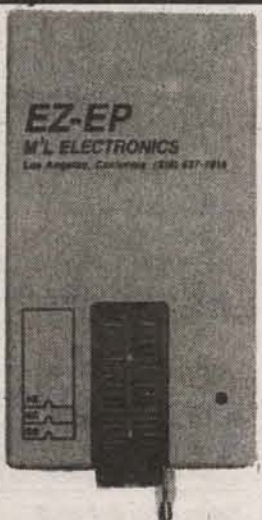
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Carl Breuning
Dartmouth College

$t(\min) = R_1 C_1 \times 2.1 = 21 \text{ min.}$

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Ring My Bell

want. According to a friend of mine at Lucent Technology, the phone line has a static line voltage of 48-54 volts DC. When the phone rings, he says, there is an additional 70 volts of AC that rides on top of the DC and rings the bell. I thought about using a 555 timer at 60 Hz feeding the secondary of a six-volt power transformer, but I'm just fishing here. Does such a circuit exist?

Skip M. Plonka via Internet

The diagram shows a 5V push-to-talk (PTT) interface circuit. It features a 5V supply connected to a 300k resistor, which is in series with a 1.3M resistor. The input signal, labeled "PRESS TO RADIO", is connected to a 10k resistor. The output of the 1.3M resistor is connected to a 300k resistor, which is in series with a 2.2k resistor. The output of the 2.2k resistor is connected to a 1N4148 diode. The output of the 1N4148 diode is connected to a 1N4733A diode. The output of the 1N4733A diode is connected to a VP2110 diode. The output of the VP2110 diode is connected to a VN2110 diode. The output of the VN2110 diode is connected to a "PHONE" input. The output of the 1N4733A diode is also connected to a 1N4733A diode, which is in series with a VP2110 diode. The output of the VP2110 diode is connected to a VN2110 diode. The output of the VN2110 diode is connected to a "PHONE" input. The output of the 1N4733A diode is also connected to a 1N4733A diode, which is in series with a VP2110 diode. The output of the VP2110 diode is connected to a VN2110 diode. The output of the VN2110 diode is connected to a "PHONE" input.

effectively grounding the green lead. When the output logic reverses, Q1 goes off and Q2 goes on, grounding the red lead; on the bottom pair, Q4 turns off and Q3 turns on, connecting the green lead to +V. This creates a 68-volt squarewave which triggers the ringer. The ringer outputs are active when both the 1.3M and 30M inputs are pulled high, either with a push-button switch (S1) or a logic gate. While the schematic shows a five-volt source, you can power the circuit from four 'C' cells without changing any values. The HV421 is available

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from **NuHorizons Electronics** (888-747-6846; <http://www.nuhorizons.com>), as are the MOSFETs.

More On Obsolete ICs

Q. I'm unable to locate a SL952 IC that is used in the Heath model SM-2420 frequency counter. Do you have information on a source or a substitute IC?

George Rooke
Upland, CA

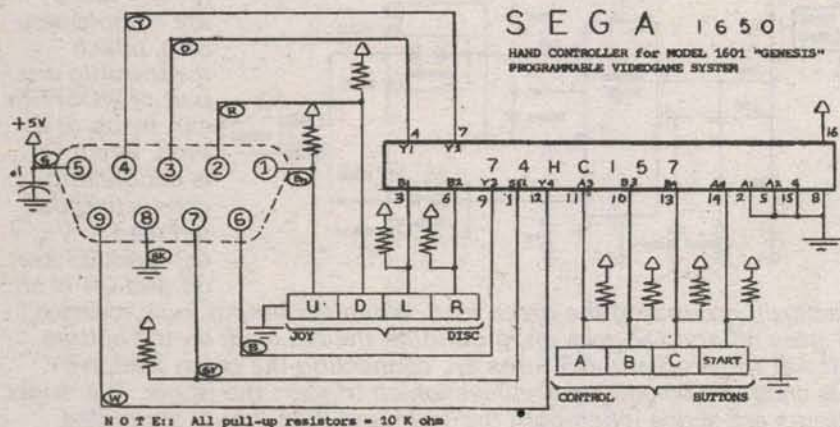
A. This chip was made by GEC Plessey Semiconductor. The company was recently acquired by Mitel, and the chip was dropped from production. Fortunately, this and many other obsolete and hard-to-find ICs can be obtained from: **Online Technology Exchange, Inc.**, 7100 Gulf Blvd., St. Petersburg, FL 33706. 1-800-606-8459; <http://www.onlinetechx.com>

Video Game Schematics

Q. I have a Sega Genesis game controller with what appears to be a nine-pin female serial connector. My goal is to build an adapter which will allow me to connect my Sega game controller to the joystick port of my PC. The project seems simple enough if I had the pinout diagrams for the Sega Genesis game controller and the joystick port of a SoundBlaster-compatible sound card. Can you provide me with this information or direct me to someone who can?

Dom Franzo
via Internet

A. I'm not so sure it's as simple as wiring one connector to another, but you definitely have to start there. I stumbled across an amazing service, called **Bomarc Services** (307-234-3488; <http://w3.trlb.com/~rollo/bomcat.htm>), that publishes schematics for many consumer products, from radios to TVs to radar — and game controllers. They generate schematics the old-fashioned Howard Sams way — by dismantling the product piece by piece. It's called reverse engineering. If they don't have your particular schematic in stock, they'll gladly create one for you at about \$20.00/hr. if you supply the device (which you get back in working order). For example, a typical two-chip remote control will cost you about \$35.00 to reverse engineer. Here's a sample of their work, which not coincidentally, is a schematic of your Sega Genesis game controller.



Many more like this are available for a reasonably priced \$1.50 each. The product catalogs, divided into 21 categories, cost three for

\$5.00 (refundable with order). Using the schematic above and a quick search of my pinout files produced the following two tables.

SoundBlaster Game Port Pinout

Pin	Function
1	+5V
2	X button, joystick A
3	X potentiometer, joystick A
4	GND
5	GND
6	Y potentiometer, joystick A
7	Y button, joystick A
8	+5V
9	+5V
10	X button, joystick B
11	X potentiometer, joystick B
12	MIDI out
13	Y potentiometer, joystick B
14	Y button, joystick B
15	MIDI in

Sega Genesis Game Controller

Pin	Function
1	UP switch
2	DOWN switch
3	Y1
4	Y2
5	+5V
6	Y3
7	SELECT
8	GND
9	Y4

Now you have to write software to sort the signals out because the Sega controller is programmable. That is, it can do many things depending on how you define the buttons. Fortunately, an engineer in Japan has posted some software clues for the Sega controller at <http://www.hongo.ecc.u-tokyo.ac.jp/~t50942/md6bpad-e.html>. However, I've found this Web link to be unreliable at times, so I took the liberty of posting the opening page, with the software commands, on our Web site (<http://www.nutsvolts.com>) under the original name of md6bpad.htm. This file can be viewed with Microsoft Explorer. While you're at it, check out this Web site (<http://hiwaay.net/~jfrohwel/tech/repair.html>), too.

Mile High PCs

Q. I work for an airline and have a question about power supply frequency, specifically about using aircraft outlets for computers. Most of the 115 VAC outlets look just like house outlets, so the computer can plug in okay. However, the aircraft frequency is 400 Hz, not the 60 Hz you find in homes. I think I once heard you can use transformer-powered 60 Hz equipment on 400 Hz, but not vice versa. Also how would this affect switching power supplies that many PCs now use?

Wayne Anderson
via Internet

A. It's true that most 60 Hz power transformers will work on 400 Hz without a hitch, but not the other way around. Why? It has to do with the metal core. As the frequency decreases, you need more metal. That's why the airlines have gone to 400 Hz. The higher frequency means less metal, which weighs less and takes up less space. Obviously, a 60 Hz transformer has more than enough metal for 400 Hz operation. However, that's presupposing that the AC is converted to DC, and that a 60 Hz timing pulse isn't a requirement. As far as I know, notebook wall chargers will run off 400 Hz.

As for switching power supplies, they are DC-operated, too. Which means, the AC voltage is first converted to high-voltage DC, then to high-frequency AC, and finally back to low-voltage DC.

Mr. NiCd

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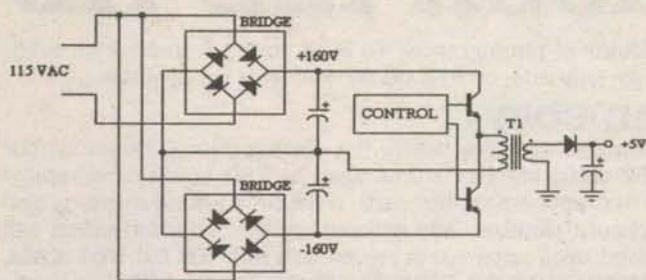
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This time, the 60 Hz AC is converted to a higher-frequency AC so that the transformer is again smaller and lighter. Since there isn't an input transformer involved, just rectifying

diodes, the switching power supply doesn't care what frequency you input. Will it work off 400 Hz? I don't see why not.

Triplett Manuals and Parts

Q. I have a Triplett Model 801 FET multimeter (analog needle display) which recently died. I suspect that one of the transistors is bad, but few of them have any markings. What I really need is a technical reference manual or schematic to fix it. Unfortunately, I have not been able to locate the Triplett company. Any suggestions?

O.C. Powell WB4WAA
Rocky Mt., NC

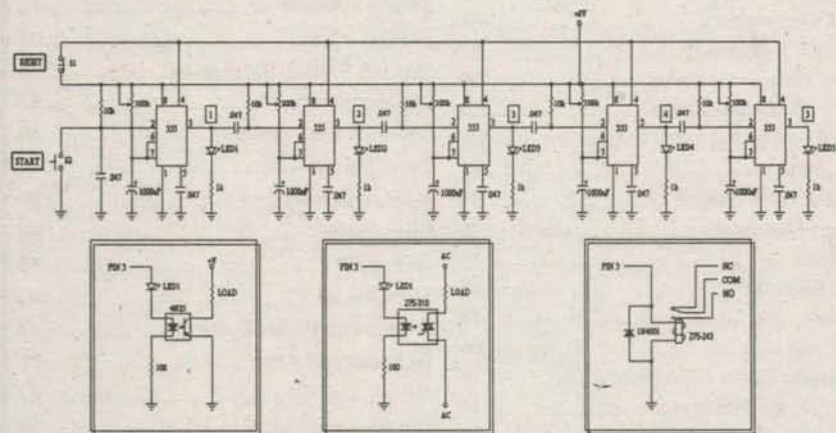
A. Triplett Corp., One Triplett Dr., Bluffton, OH 45817 (1-800-874-7538; <http://www.triplett.com>) will send you a copy of the schematic for free. Triplett can also repair your meter (write or call for a quote), or you can order replacement parts and do it yourself (there's a nominal fee for shipping and handling, usually about \$3.00). Before tearing into the instrument, though, see if the problem isn't as simple as a blown fuse. Most Triplett multimeters have two fuses, at least one of which is soldered to the circuit board. Next, look for burned (vaporized) traces, leading to a trail of scorched resistors; this is the second leading cause of failure. Good luck!

Special Effects Timer

Q. I'm in need of a digital timer that has multiple outputs. I want to use it to control the sequence of events in a portable special effects project. It has to be battery operated, or able to use a DC wall transformer, and must have a digital display of the sequence in progress. The output level isn't critical, because all I need is a relay to trigger the event. Two to five outputs would be ideal.

L. Bearden
via Internet

A. Not a tall order, but one that you'll have to be careful putting together. First, I'd use a string of CMOS 555 timers (TLC555 or equivalent) for the sequencer. They consume virtually no power, and are inexpensive (less than a buck). A five-stage sequencer looks like this.



Pressing S2 starts the sequencer, and S1 resets it. As each stage times out, the falling edge triggers the next stage. The time between stages is determined by the 100K pot and 1000 uF capacitor, which has a range of a couple of seconds up to about three minutes. As the sequence progresses, one stage turns off, and the next turns on, as indicated by the LED on the output pin (pin 3). This LED can also be used to trigger an optoisolator, to close a relay, or to control an SCR or triac. If you want both a digital indicator and an optoisolator, simply wire the two LEDs in series with an appropriate current-limiting resistor, as shown in the insert boxes. The precaution is that you must very carefully bypass each and every Vcc pin (pin 8) with a 0.1 uF capacitor and the Voltage Control pin (pin 5) with a 0.047 uF capacitor as close to the IC as possible, as shown on the schematic. Also, return all the digital grounds to one point, and the analog (LED or relay) grounds to another, then connect the two grounds together via a single wire. The circuit can be powered with four 'C' cell batteries, or from a six-volt wall transformer, like RadioShack's 273-1454.

Video RAM Requirements

Q. I'm confused about the amount of memory I need on my video card. One sales person tells me 4MB, yet another says 8MB. Can you set the record straight?

Anonymous
via Internet

A. The amount of video RAM needed is directly related to the number of colors and the number of pixels (screen resolution). The wider the color range and the more numerous the pixels, the more memory needed. As a rule, 2MB is the absolute minimum, with 8MB preferred when working in 3D color rendition. Here's a handy chart that spells it out.

Video Graphics Requirements

Palette	Refresh	Resolution	Video RAM
16-bit color	72 Hz	768 x 1024	1.5MB
24-bit color	72 Hz	768 x 1024	2.3MB
32-bit 3D	72 Hz	768 x 1024	6MB
16-bit color	72 Hz	1280 x 1024	2.5MB
24-bit color	72 Hz	1280 x 1024	3.8MB
32-bit 3D	72 Hz	1280 x 1024	10MB
16-bit color	72 Hz	1600 x 1200	3.7MB
24-bit color	72 Hz	1600 x 1200	5.6MB
32-bit 3D	72 Hz	1600 x 1200	14.7MB

MAILBAG

Dear TJ:

For a simpler, less-expensive natural gas/propane conversion mentioned in your Jan. '99 answer ("Push My Button"), look at the <http://www.uscarb.qpg.com/> Web site by **US Carburetion, Inc.**, Atlanta, GA (1-800-553-5608). I haven't used them, but wish I had found the site before buying a natural gas generator.

Jim Edwards
via Internet

Dear TJ:

I just read your Jan. '99 column, and as a licensed electrician would like to comment on Howard Epstein's unattended generator starting situation. Over the years, I've seen several "do-it-yourself" emergency power systems and most are real "time bombs." Specifically, if he's planning to connect the generator to the building's wiring system, then he must use a "Transfer Switch" (either manual or automatic). Without one, a dangerous "Backfeed" situation can occur that will feed his generated power back into the utility grid. This can injure utility workers and damage the generator (remember, you'll essentially be feeding other customers via the common grid) not to mention the problems caused if the utility returns and bucks his "plant." An alternative is to install a totally separate wiring system dedicated to the generator. In both cases, he should have a qualified electrician handle the work, follow the National Electric Code, and be inspected by the local Electrical Inspector (or Building Department).

John Henshaw
via Internet

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Alltech Electronics	24	Electronic Design Specialists, Inc.	66	Meredith Instruments	57	Skycraft Parts & Surplus, Inc.	34
Alltronics	17	Electronic Goldmine	19	Metric Equipment Sales, Inc.	69	Sky Electronics, Inc.	53
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Andromeda Research.....	16	Electronix Express	39	Micromint	31	Surplus Traders	80
Antique Radio Classified	81	EMAC, Inc.	32	Midland Technologies	80	Synergetics	83
A.S. Electronics	48	EPS	81	Motron Electronics	25	Tech 2000	58
AST Global Electronics	70	Equipment Management Technology	74	Mr. NiCd	76	Techniks, Inc.	80
Aventrade	80	ExpressPCB	33	MSC Electronics	81	Techno Lab Digital Systems	47
Baylin Publications.....	21	Fair Radio Sales Co.	49	Netcom	13	Technological Arts	60
Bilocon Corp.	81	Foss Warehouse Distributors.....	80	Norcomm	91	Telulex, Inc.	47
Bisme Computers Outlet	57	Gateway	55	Northwest Cable & Connector Co.	75	The RF Connection	38
Black Feather Electronics	88	General Device Instruments	80	Ocean State Electronics	40	Timeless Products	64
Brigar Electronics.....	12	Glentech, Inc.	80	Optoelectronics.....	4	Trenton Computer Festival.....	39
C & S Sales, Inc.	82	Graymark	28	Parallax, Inc.	Back Cover	Unicorn Electronics	67
C and H Sales Company	72	Halted Specialties Co.	3	PARAMAX, INC.	63	USI Corp.	53
Chaffin Electronics	60	H.T. Orr Computer Supplies.....	86	Patco Service, Inc.	25	Utopia Tools	38
Chenesko Products, Inc.	32	IndustroLogic	50	PCW, Inc.	34	V&V Mach. & Equipment, Inc.	80, 81
Circuit Specialists, Inc.	94	Information Unlimited	29	Phelps Instruments	68	Velleman	41
Communications Surplus.....	81	Inkjet Southwest	52	Pioneer Hill Software	73	VersaTech Electronics.....	47
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Abacom Technologies	48
Alltronics	17
Communications Surplus	81
Gateway	55
Jade Products, Inc.	80
Lemos International Co., Inc.	73
Norcomm	91
Ocean State Electronics	40
Ramsey Electronics, Inc.	45
The RF Connection	38

BATTERIES/CHARGERS

Aventrade	80
Cruising Equipment	71
Cunard Associates	84
E.H. Yost & Co.	76
Jade Products, Inc.	80
Mr. NiCd	76

BUSINESS OPPORTUNITIES

Cheneko Products, Inc.	32
------------------------	----

BUYING ELECTRONIC SURPLUS

ABC Electronics	51
Alltech Electronics	24
Black Feather Electronics	88
C and H Sales Company	72
Earth Computer Technologies	43
EPS	81
Equipment Management Technology	74
Metric Equipment Sales, Inc.	69
Roger's Systems Specialist	44
Skycraft Parts & Surplus, Inc.	34

CABLE TV

Foss Warehouse Distributors	80
James' Electronic Services, Ltd.	50
KDE Electronics Corp.	69
PCW, Inc.	34
Sam's Electronics	61
Tech 2000	58
Timeless Products	64
Wholesale Cable	16

CB/SCANNERS

Norcomm	91
USI Corp.	53

CCD CAMERAS/VIDEO

American Technologies Network Corp.	86
Black Feather Electronics	88
Circuit Specialists, Inc.	94
Decade Engineering	80
MSC Electronics	81
Polaris Industries	49
Ramsey Electronics, Inc.	45
Resources Un-Ltd.	36
Seabird Technical	81
SuperCircuits	51
USI Corp.	53

COMPONENTS

Communications Surplus	81
Electronic Goldmine	19
EPS	81
La Paz Electronics Int'l.	72
Linear Systems	15
Ocean State Electronics	40
Pulsar, Inc.	88
SIGEM	81
Skycraft Parts & Surplus, Inc.	34
Unicom Electronics	67
Visitec, Inc.	59

COMPUTER

Hardware	
ACP Super Store	86
Allison Technology Corp.	51, 80
Alltech Electronics	24
AM Research, Inc.	31
Bismar Computers Outlet	57
Chaffin Electronics	60
Consumertronics	18
Corporate Systems Center	2, 95
DMD Systems Recovery, Inc.	81
Earth Computer Technologies	43
Electro Mavin	71
General Device Instruments	80
Halted Specialties Co.	3
La Paz Electronics Int'l.	72
MCM Electronics	65

Northwest Cable & Connector Co.	75
Roger's Systems Specialist	44
Shreve Systems	80
Techniks, Inc.	80
Techno Lab Digital Systems	47

Software

AM Research, Inc.	31
Bismar Computers Outlet	57
Electronix Corp.	75
Pioneer Hill Software	73
R & D Books	15

Microcontrollers / I/O Boards

Abacom Technologies	48
Advanced Educational Systems	50
AM Research, Inc.	31
Bismar Computer Outlet	57
EMAC, Inc.	32
IndustroLogic	50
JK microsystems	81
La Paz Electronics Int'l.	72
Lemon-Pladd, Inc.	14
Micromint	31
Motron Electronics	25
Parallax, Inc.	Back Cover
PARAMAX, INC.	63
Prairie Digital, Inc.	81
R.E. Smith	80
Scott Edwards Electronics	85
Square 1 Electronics	33
Technological Arts	60
VersaTech Electronics	47
Vesta Technology, Inc.	81

Printers/Printer Supplies

Cheneko Products, Inc.	32
H.T. Orr Computer Supplies	86
Inkjet Southwest	52

DESIGN/ENGINEERING SERVICES

ExpressPCB	33
Midland Technologies	80
Pulsar, Inc.	88
Sky Electronics, Inc.	53
V&V Mach. & Equipment, Inc.	80, 81

EDUCATION

Advanced Educational Systems	50
Electronix Corp.	75
EMAC, Inc.	32

EVENTS/SHOWS

ACP Super Store	86
Trenton Computer Festival	39

KITS

Alltronics	17
C & S Sales, Inc.	82
Digital Products, Inc.	80
Earth Computer Technologies	43
Edlie Electronics, Inc.	42
Electronic Goldmine	19
Electronic Rainbow Ind., Inc.	46
EMAC, Inc.	32
Gateway	55
Information Unlimited	29
Inkjet Southwest	52
Jade Products, Inc.	80
Lemon-Pladd, Inc.	14
Ocean State Electronics	40
Quality Kits	14
Ramsey Electronics, Inc.	45
Scott Edwards Electronics	85
SIGEM	81
USI Corp.	53
Velleman	41
Weeder Technologies	77

LASERS

Information Unlimited	29
Meredith Instruments	57
Resources Un-Ltd.	36
Unicom Electronics	67

MISC./SURPLUS

All Electronics Corporation	54
Alltech Electronics	24
Black Feather Electronics	88
Brigar Electronics	12
C and H Sales Company	72
Chaffin Electronics	60
Communications Surplus	81
Consumertronics	18
Cyber-Test Incorporated	66
DeMar Electronics	81
Electronic Goldmine	19
Electronic Rainbow Ind., Inc.	46
EPS	81

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FAST
BY PRODUCT
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CATEGORY

Equipment Management Technology	74
Fair Radio Sales Co.	49
Gateway	55
Halted Specialties Co.	3
Lifeline Electronics, Inc.	72
Linear Systems	15
Resources Un-Ltd.	36
Shreve Systems	80
Skycraft Parts & Surplus, Inc.	34
Surplus Traders	80
Unicom Electronics	67
Viking International	21
Visitec, Inc.	59
Weeder Technologies	77

PROGRAMMERS

Andromeda Research	16
General Device Instruments	80
Intronics, Inc.	84
M2L Electronics	74
microEngineering Labs	28

PUBLICATIONS

Antique Radio Classified	81
Consumertronics	18
LLH Technology Publishing	20
Netcom	13
R & D Books	15
Square 1 Electronics	33
Synergetics	83

ROBOTICS

Abacom Technologies	48
Lemos International Co., Inc.	73
Lynxmotion, Inc.	76
PARAMAX, INC.	63
SuperCircuits	51

SATELLITE

Baylin Publications	21
SIGEM	81

SECURITY

American Technologies Network Corp.	76
A.S. Electronics	48
Information Unlimited	29
Lemos International Co., Inc.	73
Lifeline Electronics, Inc.	72
Matco, Inc.	81
MSC Electronics	81
Norcomm	91
Polaris Industries	49
SuperCircuits	51
Visitec, Inc.	59

SOLAR EQUIPMENT

Cruising Equipment	71
--------------------	----

STEPPER MOTORS

Alltronics	17
PARAMAX, INC.	63

TELEPHONE

Bilocon Corp.	81
Digital Products, Inc.	80
M.F.M. Communications	58
Telulex, Inc.	47
Weeder Technologies	77

TEST EQUIPMENT

ABC Electronics	51
Alfa Electronics	57
Allison Technology Corp.	51, 80
AST Global Electronics	70
C & S Sales, Inc.	82
C and H Sales Company	72
Circuit Specialists, Inc.	94
Cruising Equipment	71
Davilyn Corp.	11
Digital Products, Inc.	80
DMD Systems Recovery, Inc.	81
Electronic Design Specialists, Inc.	66
Equipment Management Technology	74
Electro Tool, Inc.	53
Glentech, Inc.	80
Intronics, Inc.	84
J-Works, Inc.	61
MCM Electronics	65
Metric Equipment Sales, Inc.	69
Optoelectronics	4
Phelps Instruments	68
Pioneer Hill Software	73
R & S Surplus	35
Saelig Company	43
Seabird Technical	81
Telulex, Inc.	47
Western Test Systems	22-23

TOOLS

C & S Sales, Inc.	82
Electro Tool, Inc.	53
Graymark	28
Lemon-Pladd, Inc.	14
Patco Service, Inc.	25
The RF Connection	38
Utopia Tools	38

WIRE/CABLE & CONNECTORS

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Roger's Systems Specialist	44
The RF Connection	38

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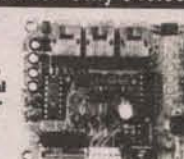
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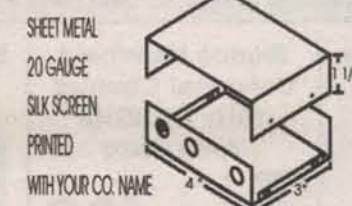
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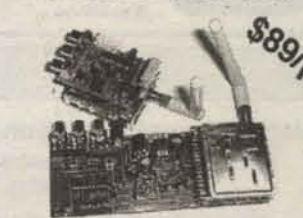
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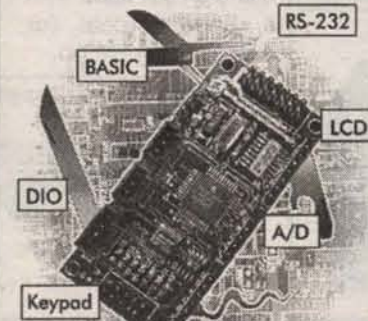
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This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

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- 0.2Hz to 20MHz
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- Burst Operation
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- Linear and Log sweep

BK PRECISION

10MHz Model 4017 \$309

5MHz Model 4011 \$239

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- Sensitivity:**
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 - <8mV @ 250MHz
 - <8mV @ 10Hz
 - <100mV @ 2.4GHz

Features 10 digit display, 16 segment and RF signal strength bargraph. Includes antenna, NiCad battery, and AC adapter.

B&K Frequency Counter Model BK-1875



**1Hz - 2.8GHz
3 Channels**

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 - <7mV @ 1GHz
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Ultra sensitive synchronous detector bargraph and RF strength.

Elenco RF Generator with Counter (100kHz - 150kHz) Model SG-9500



Features internal AM mod. of 1kHz, RF output 100MV - 35MHz. Audio output 1kHz @ 1V RMS.
SG-9000 (analog, w/o counter) \$119.95

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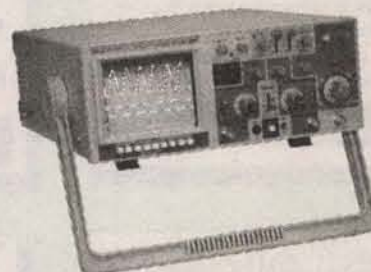


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Don Lancaster's

RESOURCE BIN

number eighty seven

Exploring used test equipment options.

Our usual reminder here that the *Resource Bin* is a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

Finding Decent Used Test Equipment

You'll find a lot of incredible buys in used test equipment if you shop around. Brought about by military and aerospace cutbacks, those schools dropping their electronics programs, and the big shift towards modeling, simulation, and computer control. On the other hand, there sure is a lot of outrageously heavy and ridiculously oversized junk out there.

Much of it totally useless.

How do you separate the goodies from the grunge?

A better home lab should have at least a good power supply or two, a multimeter, a scope, a *BASIC Stamp* by Parallax, and a function generator. For "level II," you'll add such goodies as frequency counters, signal generators, computer emulators, some RF gear, and more specialized devices.

Your first and foremost choice for used electronic test equipment should be right here in *Nuts & Volts*. Where you will find hundreds of ads spread out over dozens of categories. But let us take a tour of your other options in pinning down superb prices on used test gear. Let's start with ...

The Blue Book

The closest thing I have found to a used test equipment blue book is the *Test Equipment Connection* free catalog. From www.4testequipment.com.

This *essential* catalog instantly tells you which equipment stays popular. Along with relative prices. Primarily for H-P and Tek, of course. But *Fluke*, *Racal*, *Wavetek*, and a few dozen or so

other sources are also included.

If a piece of gear is not in this catalog, the chances are it is not worth buying.

I'll typically divide their prices by 30 to come up with reasonable bids on skidded surplus lots. Never go to any auction or a hamfest without at least one copy of their catalog.

But do keep it well hidden.

NEXT MONTH:
Don finds the hydrogen scene is a gas.

Some Sources

As with most any field, you'll get what you pay for. Depending on how price limited you are and how much risk you are willing to take, there are several choices here ...

Prime Suppliers — These firms provide like new condition, full manuals, support, leads, accessories, and even standards tracability. Typical outfits are *Danbar*, *Davilyn*, *Tucker*, *Test Equipment Plus*, *Naptech*, the *Test Equipment Connection*, *TestEquity*, *ValueTronics*, *Western Test Systems*, and a dozen others.

Bargain Sources — The bargain sources typically charge only one-half to one-third of the regular price. But all you could end up with is the instrument itself, reasonably clean, and checked only for obvious faults. Manuals are usually extra, and guarantees may be limited. Availability may be restricted to stock on hand, rather than what you really want. The lower prices are possible because of lower ad staff, and overhead costs.

Hamfests and Newsgroups — These are often your cheapest sources for single quantities of useful test gear. But they are also the ones with the highest risk. And possibly the highest rewards. We will see more on these shortly.

Wholesale Auctions — The lowest prices are gotten by buying blind in skid lots from military auctions and industrial distress sales. High quantities and high risks are involved. The process may take many weeks and involve truck rentals and travel to places you really did not want to go to. Again, we'll see more details below.

Hamfests

Hamfests are technical flea markets and tailgating parties put on by local amateur radio clubs. You should find hundreds of these yearly, ranging from a few locals gathering together to statewide regional meets. On up to their huge yearly Dayton show.

A wide variety of bargain priced test equipment is often featured from dozens to hundreds of individuals or commercial vendors. Admission is from free to nominal for buyers. Keep in mind that what you see is what you get. And that the ultra low prices can represent higher risks. If you don't know what you are buying, ask for expert help. There's always bunches of it nearby at a hamfest.

Really great buys are the norm.

Speaking of which, you'll always get the best buys before sun-up or very late in the day. Very early to grab the goodies ahead of the hoarders. And late because a seller may be under a "get rid of all that junk or don't come back" edict.

These days, there are also lots of *virtual hamfests* that are simply online classifieds that happen to cater to the amateur radio needs.

There's also a lot of hamfest info on the web. Just punch "hamfest" into www.hotbot.com to get many thousands of links. Add a state name to narrow your search.

Or, you can start off with these real hamfest directory sites ...

www.arl.com/field/hamfests
www.seanet.com/~bobjr/hfest.htm
www.vartel.com/hamfest.htm

Or these virtual ones ...

www.hamfest.net
<http://vhamfest.com>

Lots of hamfests are in the monthly *Nuts & Volts* events calender.

Newsgroups

Some of the best test equipment bargains of all can usually be found in the Usenet newsgroups. Your most useful one is *sci.electronics.equipment*. But also check *sci.electronics.repair*

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and *sci.electronics.misc*.

But buyer beware, empty cravats, and all that other stuff.

The newsgroup access is sometimes free with your Internet account. Other times, there is a low extra monthly charge. Be sure to ask your ISP if you are having access problems.

If you can't access a newsgroup any other way, use www.dejanews.com.

Auctions

Auctions are interesting but

RESOURCE BIN

SOME USEFUL TEST EQUIPMENT RESOURCES

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Alfa Electronics Inc PO Box 8089 Princeton NJ 08543 (609) 897-1135	Danbar 14455-C N 79th St Scottsdale AZ 85260 (602) 483-6202	Glentech Inc 731 W Lunt Ave Schaumburg IL 60193 (847) 891-2584	Parallax 3805 Alherton Rd #102 Rocklin CA 95765 (916) 824-8333	Test & Measure World 275 Washington St Newton MA 02158 (617) 558-4671
Allison Technology Corp 2006 Finney Valley Rd Rosenberg TX 77471 (281) 239-8500	Davilyn Corp 13406 Saticoy St North Hollywood CA 91605 (818) 787-3334	Stan Griffiths 18955 SW Blanton Aloha OR 97007 (503) 649-0837	Phelps Instruments 2631 Hillside Ave Norco CA 91760 (909) 279-7347	Test Equip Connection 525 Technology Park Lake Mary FL 32746 (800) 615-8378
AST Global 24529 St Hwy 408 Cambridge Springs PA 16403 (814) 398-8080	Digital Products Inc 134 Windstar Cir Folsom CA 95630 (916) 985-7219	Intronics Inc Box 13723/612 Newton St Edwardsville KS 66113 (913) 422-2094	Pioneer Hill Software 24460 Mason Rd Poulsbo WA 98370	Test Equipment Plus 3331 W Bright Terrace Tucson AZ 85741 (520) 575-6967
Auction Advisory Box 61104 Phoenix AZ 85082 (602) 994-4512	Electronic Design Specialist Inc 4647 Appalachian St Boca Raton FL 33428 (561) 487-6103	J-Works Inc 12328 Gladstone St #4 Sylmar CA 91342 (818) 361-0787	R&S Surplus 1050 E Cypress St Covina CA 91724 (626) 967-0846	TestEquity 2450 Turquoise Circle Thousand Oaks CA 91320 (800) 228-3457
Bentley Auctioneers 3801 Academy Pkwy NE Albuquerque NM 87109 (505) 344-1812	eBay 2005 Hamilton Ave, #350 San Jose CA 95125 www.ebay.com	Jnl of Electronic Test 101 Philip Dr Norwell MA 02061 (781) 871-6600	Racal Instrument PO Box C-19541 Irvine CA 92718 (949) 859-8999	Tucker 1717 Reserve St Garland TX 75042 (800) 527-4642
C&S Sales Inc (Elenco) 150 W Carpenter Ave Wheeling IL 60090 (847) 541-9904	Electro Tool Inc 9103 Gilman Livonia MI 48150 (734) 422-1221	Levy Latham 6263 N Scottsdale #371 Scottsdale AZ 85250 (602) 367-1100	Saelig Company 1193 Moseley Rd Victor NY 14564 (716) 425-3753	ValueTronics 1925 S Wright Blvd Schaumburg IL 60193 (800) 552-8258
C & H Sales Inc 2176 E Colorado Blvd Pasadena CA 91107 (800) 325-9465	EMF-EMI Control PO Box D Gainesville VA 20156 (540) 347-0030	Metric Equipment Sales 3486 Investment Blvd Hayward CA 94545 (800) 432-3424	Seabird Technical 3580 Haven Ave Redwood City CA 94063 (650) 367-8320	Wavetek 9054 Balboa Ave San Diego CA 92123 (619) 279-2200
Circuit Specialists Inc 220 S Country Club Dr Mesa AZ 85210 (602) 464-2485	Equipment Management Technology 837A Industrial Rd San Carlos CA 94070-3312 (650) 631-1700	Naptech 11270 Clayton Creek Rd Lower Lake CA 95457 (800) 336-7723	Synergetics Box 809 Thatcher AZ 85552 (520) 428-4073	Western Test Systems 530-C Compton St Broomfield CO 80020 (303) 438-9662
Compliance Engineering 629 Massachusetts Ave Boxborough MA 01719 (508) 264-4208	Evaluation Engineering 2500 Tamiami Trail North Nokomis FL 34233 (941) 966-9521	Nuts & Volts 430 Priceland Ct Corona CA 91719 (909) 371-8497	Tektronix PO Box 500 Beaverton OR 97077 (800) 835-9433	

risky places to pick up used test equipment. Their prices will sometimes end up extremely low. Particularly when you choose obscure enough auctions, the weather is lousy, it is midweek, and you are the only one bidding. And if you do not commit to excessive time, dollars, and ego

while attending. The usual trick is to try and score several identical units so you can make a few good instruments out of the lot.

If you are doing this commercially, the object of surplus is to buy for a penny on the dollar, sell for a dime, and try to make a nine percent profit while doing so. Lean

and mean is the *only* route that works here. Auction sources include community colleges, commercial test equipment auctions, business liquidations, mil surplus, and live online venues ...

Community Colleges — Many of these colleges are phas-

ing out or sharply cutting back on electronics programs. A few years back, I bought an *entire* electronics department at auction for an obscenely low price. And made more from it than I did in 10 years of teaching for them.

Ask *all* the schools even remotely near you for ongoing auction info. You'll do best with outlying schools in small rural communities.

For higher profile examples, see www.dist.maricopa.edu.surplus or check w3.arizona.edu/~surplus/public/index.html.

Commercial Test Equipment — Several auctioneers specialize in commercial test gear. Mountains of stuff are often available, but the competition can also be fierce. Many of these are held in high tech areas. Albuquerque shows by *Bentleys* are examples.

At www.bentleysauction.com.

Business Liquidations — The listings of these often do appear in the regional auction directories. My favorite here is the Southwest *Auction Advisory*. It is also located online at, of all places, www.auctionadvisory.com. I've found best results when a few odd test items are included in an auction that moves lots of non-technical stuff.

Military Surplus — We have seen in previous columns how outstanding buys in mil surplus test equipment are easily gotten. You can now bid and pay online, and certain sales even deliver. The website is www.drms.com. Some mil stuff is now being handled commercially. See www.levy-latham.com.

Live Online Auctions — The real biggie here, of course, is www.ebay.com. Who are now milking auction addicts for all they are worth. And then some. eBay is strongest in collectibles, but more and more test equipment is now starting to appear. I found 313 power supplies, 68 oscilloscopes, and 42 meters listed on a recent check. Sadly, a lot of these were ancient junk. Or were otherwise second rate. This also seems more of a place to sell than buy, because I've found many of their prices tend to end up higher than you can find elsewhere. Be sure to watch your time and energy commitment.

I do prefer sealed bid sales to live auctions because you'll have less time commitment and you are more likely to score genuine bargains. Especially when you intentionally bid low and expect very few hits. A "never be underbid"

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19A704860P(1800mAh) \$ 39.95	1000 1100 1200 \$ 34.95	KENWOOD
PL190429763(777)G1/3 \$ 37.95	BP100/200/205 \$ 14.95	PB2 / KNB3 \$ 29.95
	205 Inc to 1350 \$ 22.95	PB21/21H \$ 14.95
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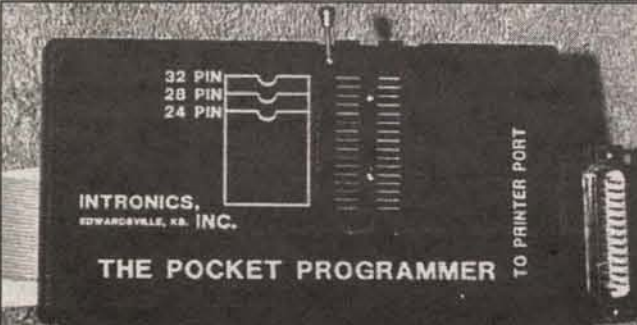
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RESOURCE BIN

play will sometimes work amazingly well. The time and energy spent on pickup can also be adjusted to the value of the goodies.

It also pays to line up "associates" or "agents" who you might trade off inspection and shipping with. This can minimize non-productive travel.

For More Help

There's also a freebie trade journal called *Test & Measurement World* that sometimes has useful ads and info in it. Some more specialized instruments also appear in *Compliance Engineering*.

More obscure titles are *EMF-EMI Control*, *Evaluation Engineering*, and the pricey *Journal of Electronic Testing*.

Oscilloscopes — Restoring a Classic is your definitive Stan Griffiths book on this.

I can try to answer most simple test equipment questions free by E-Mailing me at don@tinaja.com.

The older personal computers can sometimes substitute for test gear and signal generators. You can usually make them do exactly what you want. I've got great

heaping bunches of Apple IIe and Mac LC computers available at very low cost if you want to explore these areas.

This Month's Contest

As our contest for this month, just tell me about some bargain source of electronic test equipment that I don't know about and that you can strongly and honestly recommend.

There'll be a dozen or more of my new *Incredible Secret Money Machine III* books going to the better entries. And an all expense paid *tinaja quest* for two (FOB Thatcher, AZ) going to the very best entries of all.

Send your written and snail-mailed entries on this contest directly to me here at Synergetics. NV

Don is the webmaster of his Guru's Lair found at <http://www.tinaja.com>. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to don@tinaja.com.

Scott Edwards Electronics

NEW! Graphics LCD Module with Serial Interface



The new G12864 makes it easy to display text and graphics on a 128-by-64-pixel LCD. It interfaces with a computer through a 2400 or 9600-baud RS-232 serial hookup.

Text Features

The G12864 works like a serial-receive terminal. It displays text in a 4-line by 16-character format. Text is displayed in a large 8- by 16-pixel font, which can be edited to include custom symbols.

Graphics Features

The display lets you plot points, draw lines, and display full-screen graphics using easy instructions. Its flash memory stores the text font plus 14 screens. You can create fonts and graphics on your PC, then download them to the G12864 using the included software.

Convenience Features

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Events CALENDAR

Continued from page 57

MAY 16

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Altembernd KA1MQX, 617-253-3776. Web: <http://web.mit.edu/w1mx/www/swapfest.html>

NH - LONDONDERRY - Hamfest. Paul KILL, 603-432-1538

MAY 22

NH - DERRY - Hamfest. Londonderry Lions Club, Mammoth Rd. Rt. 128. 8am-1pm. The Interstate Repeater Society ARC, Paul 603-432-1538. E-Mail: killx@juno.com

MAY 22-23

WA - YAKIMA - WA State Convention. Yakima ARC, C. Jo Whitney KA7LJQ, 509-965-3379. E-Mail: kb7hdx@televar.com Web: <http://eagle.yk.com/~w7aq/hamfest.html>

MAY 23

CA - SACRAMENTO - Hamfest. North Hills RC, Earl Mead K6ESM, 916-331-1115. E-Mail: nhrc@k6is.org Web: <http://www.k6is.org>

MAY 29

CANADA - MANITOBA - WINNIPEG - Hamfest. Winnipeg ARC, Ed Henderson VE4YU, 204-694-0667. E-Mail: edve4yu@pangea.ca

CT - VERNON - Hamfest. Natchaug ARC, Wayne Rychling N1GUS, 860-487-1921. E-Mail: wrych@neca.com

NC - DURHAM - Hamfest. Durham FM Assn., Joseph Fields KF4QYY, 919-596-3738. E-Mail: dfma@vramp.net

Web: <http://www.vramp.net/~dfma>
NY - PLATTSBURGH - Hamfest. Champlain Valley ARC, Bernhard Jakobetz KC2ALG, 518-643-9657

MAY 29-30

WY - CASPER - State Convention. Casper ARC, Warren "Rev" Morton WS7W, 307-235-2799 (H), 307-237-9301 (W). E-Mail: mortonwg@aol.com Web: <http://w3.trib.com/~carc/hamfest.html>

MAY 30

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

CANADA - QUEBEC - SOREL-TRACY - Hamfest. Le Club RA, Jean Gadoury VE2UL, 450-836-3072. E-Mail: alaing@autray.net

JUNE 1999

JUNE 4-5

NE - SOUTH SIOUX CITY - Convention. 3900 Club & Sooland ARA, Mike Nickolaus NF0N, 402-494-6070. E-Mail: nf0n@avalon.net

JUNE 4-5-6

NY - ROCHESTER - Convention. Monroe County Fairgrounds. Fri: 12pm-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Harold Smith K2HC, 716-424-7184. E-Mail: rochfst@frontier.net Web: <http://www.rochesterhamfest.org>

JUNE 5

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

IL - SPRINGFIELD - Hamfest. Sangamon Valley RC, Ed Gaffney KA9ETP, 217-628-3697. E-Mail: egaffney@fgl.net

Web: <http://www.skylight1.com/svrc>

ME - HERMON - Hamfest. Hermon High School. 8am-1pm. VE Exams. Talk-in: 146.34/94, 146.52. Pine State ARC, Roger Dole KA1TKS, 207-848-3846. E-Mail: dolerw@juno.com

MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. VE Exams. Talk-in: 147.160 link repeater system. Independent Repeater Assn., Kathy KB8KZH, 616-698-6627 4-7pm.

MN - ST. PAUL - Hamfest. TwinsLan ARC, Ann Foster NOLL, 612-706-1761. E-Mail: tailgate@twinslan.org

JUNE 5-6

GA - MARIETTA - Hamfest. Jim Miller Park.

Atlanta Radio Club, Ben Dasher KE4YZX, 404-869-6959. E-Mail: bendasher@mindspring.com Charles Golsen N4TZM, 404-252-3303. E-Mail: cgolsen@atlanta.com

OR - SEASIDE - SEAPAC Ham Convention. Seaside Convention Center. VE Exams. Randy Stinson K27T, 503-297-1175. E-Mail: rastinson@att.net Web: <http://www.otvarc.org/events/hamfairs/seapac/index.htm>

JUNE 6

IL - PRINCETON - Hamfest. Starved Rock RC, Frank Carraro KF9NZ, 815-856-3773. E-Mail: w9mks@qsl.net Web: <http://www.qsl.net/w9mks/>

NY - QUEENS - Hamfest. Hall of Science parking lot, Flushing Meadow Park Corona, 47-01 111th St. 9am-3pm. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599. E-Mail: WB2KDG@Bigfoot.com

OH - MEDINA - Hamfest. County Fairgrounds, Community Center, 735 Lafayette Rd. 8am-3pm. Talk-in: 147.630 in, 147.030 out. Medina 2 Meter Group, Mike Rubaszewski N8TZY, 330-273-1519. E-Mail: m2mggroup@aol.com

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Mary Lu Blassell KB4EFB, 703-369-2877

JUNE 11-12

GA - ALBANY - Convention. Albany ARC, Ricky McCrary KD4OZR, 912-438-9714. E-Mail: rmcrary@plantel.net Web: <http://www.isoa.net/aarc>
TX - ARLINGTON - Convention. HAMCOM, Jim Haynie W5JPB, 214-351-3271. E-Mail: jimhaynie@aol.com

JUNE 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

CANADA - ONTARIO - FERGUS - Hamfest. Guelph & Kitchener-Waterloo ARCs, Bill Smith VE3WHS, 519-821-6642. E-Mail: smith.ve3whs@sympatico.ca Web: <http://www.kwarc.org/fleamarket>

CT - GOSHEN - Hamfest. Southern Berkshire ARC, Lee Collins K1LEE, 860-435-0051. E-Mail: collins@li.com

MA - FALMOUTH - Hamfest. Falmouth ARA, Ralph Swenson N1YHS, 508-548-6405. E-Mail: depsher911@aol.com Web: <http://www.falara.org>

MO - MACON - Hamfest. Macon County ARC, Dale Bagley K0KY, 660-385-3629. E-Mail: dbagley1@istmacon.net Web: <http://www.istmacon.net/~kfoster/hamfest.htm>

NC - WINSTON-SALEM - Hamfest. Tom Gallagher N4IOZ, 336-723-7388. E-Mail: n4ioz@ibm.net Web: <http://members.xoom.com/w4nc/>

PA - BLOOMSBURG - Convention. Columbia-Montour ARC, Dave Schack WC3A, 717-752-6851. E-Mail: kev17815@epix.net Web: <http://www.bafn.org/~cmarc>

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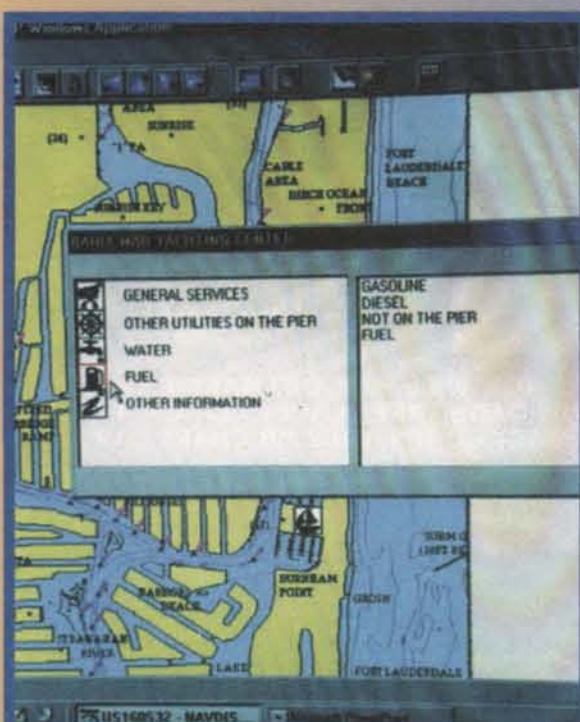
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MARINE ELECTRONICS FOR THE LAND RV MARKET

by Gordon West



**MARINE AND LAND SOFTWARE FOR
BOATS AND RVs WITH A LAPTOP
COMPUTER ON BOARD.**

Electronics that go into boats and vehicles share a lot of common applications. Both boats and cars run on 12 volts. Boats and RVs are regularly plugged into 110 VAC when at the dock or at the campsite. Both types of moving vehicles may generate radio reception interference, and both the sailor, as well as the RVer want to know exactly where they are at anytime. Both sailors and RVers are always interested in upcoming weather conditions, and both the boat, as well as the vehicle may require special grounding techniques in order to make the radio and navigation receiving equipment work properly.

If you compare a big, thick marine electronics discount catalog to a big, thick RV accessories catalog, you will see many manufacturers displaying similar equipment for both markets.

And this is good for us. The more avenues of sales and distribution, the greater the volume of equipment sold, and individual equipment prices become quite affordable.

There is also the advantage of technology exchanges between both mobile markets. Portable electronics for boats must be absolutely waterproof to the point of passing a submersion test. For the RV market, this means you can take your little portable radio or navigation receiver out on the snowmobile or in a driving rainstorm, and have it survive without water damage. And this same piece of equipment might show land navigation streets and freeways when you are in the RV, and then double

as a marine electronic charting device when out on the waves. So, here are some double-duty electronics that can very well satisfy the requirements of both sailors, as well as land rovers.

HIP-POCKET GPS

Garmin and Magellan are the undisputed GPS pace-setters. Both companies were one of the first to offer a marine low-cost, portable GPS receiver well before the entire GPS constellation was in place. In fact, during Desert Storm, civilian receivers were in high demand by the military, even though they lacked the secondary military receiving frequency for a more precise position fix. As you may remember, the military turned Selective Availability to zero during much of the Crisis. (Selective Availability is the military's on-purpose dithering of clock time to deny unfriendly use of this worldwide navigation system by the enemy.)

Magellan has just announced a \$50 million joint-venture with Hertz to equip 50,000 rental cars in the United States, Europe, and Canada with next-generation navigation technology. The Magellan "Smart Car" navigation technology allows users to simply input a local street address, or choose from a range of destinations including hotels, airports, restaurants, and points of interest.

Magellan then transforms this technology into their portable marine navigation receivers, putting in marine "points of interest" such as fuel docks, buoys, lighthouses, and yacht clubs.

But Garmin counters with a \$300.00 portable that lets you upload from CD-ROM cartography street-level mapping, and without any cartography upload, a base map showing major highways and secondary roads including information about available lodging, food, and service stations in their GPS III.

But Garmin is best-known for their StreetPilot that can be ordered in a monochrome readout or, for in-vehicle use, color LCD readout. The StreetPilot sells for around \$550.00, and includes the embedded base map that gives you sufficient detail and guide to services to easily get you across the United States.

The StreetPilot is more designed for the RVer than the mariner because coastline detail is not intended for navigating in and out of harbors on the screen. Freeways yes, harbors no.

To get down to street level, you need to purchase a local area Garmin street map cartridge using ETAK cartography that has been updated to 1998 roads. The cartridges could cost anywhere from \$100.00 to \$300.00, depending on how many MB to cover a specific geographic area. ETAK and Garmin have done a good job to structure their cartography so as not to drop out in an important area when leaving or entering town.

"When comparing the StreetPilot plug-in cartridges to the CD-ROM cartography, we see many more new roads and new freeways appearing on the little expensive cartridges than what we see coming from the CD-ROM," comments Joel Levy, an avid mariner and RVer.

Lowrance is also bridging the land and ocean markets with a GPS charting receiver called GlobalMap 1600. "We have designed this product for both the land and marine markets," comments Chad Worford of Lowrance. "Our MapSelect/MapCreate software enables sailors and RVers to selectively upload street-level cartography for driving in any city in the USA, worldwide cartography of major highways, inland lakes and rivers cartography for freshwater fishermen, and marine cartography for US coastal wrecks, obstructions, and selected navigational aids," adds Chad. You upload a specific 2 MB of marine or land street detail by connecting the dots seen on your laptop screen on the Lowrance fixed or portable GPS charting equipment. A small city takes under 1 MB of memory, yet a big city like Los Angeles gobbles up almost 2 MB. The upload takes place at 57,600 baud, so it takes about 10 minutes for a complete memory upload of your desired cruising or driving location.

"You simply draw the border around the area of interest by clicking on grid marks, and each click draws part of the box around an area of the map. When the box is complete, you simply click on the create map icon and save it to the hard drive, or upload it to the Lowrance dis-



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**AUTHOR WEST (R) GETS THE STRAIGHT
SCOOP ON GPS AT THE MAGELLAN
BOOTH AT A COMBO MARINE/RV SHOW.**



THE UPLOAD BLANKS OUT WHEN MEMORY IS FILLED TO CAPACITY ON THE PORTABLE GPS.



LAND CARTOGRAPHY IS NOT SUITABLE FOR DETAILED OCEAN AND HARBOR NAVIGATION.



HOW WILL MAP AND MARINE CHART UPLOADS TAKE PLACE? CD-ROM, PCMCIA CARTRIDGES, OR 2 MB CHART CARDS?

play unit," comments Julian Frost, a computer expert who advises me on the latest in GPS technology.

When viewing the Lowrance street cartography, there is plenty of detail, down to 500 feet, but the streets don't have quite the finished look that you would get on the Magellan or Garmin land units. We also saw some overlay discrepancies where streets extended out into the ocean, rather than ending at a cul-de-sac on a bluff. But this is a relatively inexpensive (under \$500.00) unit, and you really can't compare it to those in-vehicle, permanently-installed mapping devices which cost over \$1,000.00 plus additional costs to unlock specific areas on the CD-ROM.

So will we end up with cartography on a chip or on CD-ROM? Will CD-ROM providers give us the entire United States, or give us specific cities that must be electronically purchased by unlocking portions of a CD-ROM? Manufacturers and CD-ROM mapping companies are still working on the best way to present these products to both sailors, as well as land users.

WET TALK

Handheld two-way radio manufacturers have now developed methods to keep water out of the insides of their equipment. Standard Communications, the marine electronic giant who first pioneered a Japanese VHF handheld transceiver, offers a submersible Model HX350 for around \$275.00 that works on all marine domestic and international channels. They also have a new fixed-mount marine VHF that can actually float — although I can't imagine why any mariner would want a floating 25-watt radio still hooked up to their 12-volt battery system aboard!

Standard Communications has just been acquired by amateur radio giant Yaesu, and this

means ham operators may soon find submersible handheld equipment sharing the design from Standard's marine radio line. We will also see Standard Communications ending up with a dandy long-range, single-sideband radio, designed by Yaesu.

But no one knows what may happen to the popular Standard radio line of ham equipment, marketed out of Chicago, and principally sold by TechAmerica. Yaesu's buy-out of Standard was just their marine and land-mobile divisions, not the ham division. You figure it out!

Garmin is now in the submersible market, and under \$160.00 with their Model VHF720 all-channel marine VHF handheld. And Garmin JUST announced a new cellular phone product that incorporates a GPS receiver and GPS charting so you can call up another Garmin cell phone, and you can each look on your own display and see where the called party is located.

Garmin also offers a service that would allow RVers and boaters to call a designated Garmin service provider; and as soon as the Garmin cell phone rings through, they know your location by an embedded GPS datastream, and can send help to you whether you are on the freeway or in mid-channel taking on water.

Or maybe you are out skiing, and a white-out gets you completely turned around. You can either watch your combined cellular/GPS screen for a track back to civilization, or dial an emergency help number and let them see your position to arrange help to be brought in. And yes, this equipment is also waterproof, too, against waves, snow, and driving rain.

COMS AND NAV

There is no comparison between factory-installed vehicle GPS navigation systems offering incredible local advantages over portable equipment that does double-duty aboard boats

and land yachts. However, the double-duty portable equipment is far less expensive, and can be taken virtually anywhere without a hard-wire vehicle system. The portables can also work the trails, the ski slopes, snowmobile paths, and could even survive an accidental shallow-water dunking.

But the big question is how the cartography will ultimately upload into portable equipment. Will the relatively expensive 1 MB, 2 MB, and 3 MB chip cards remain in our future, or will we buy cartography off of the web by unlocking CD-ROM mapping and charting fields? Or maybe the cartography will be absolutely free, and you can load as much from your computer to your GPS set as your portable equipment can hold. But what are you going to do when you are out there in one region, and now move into another region, and your laptop has been left behind? Now the chart cartridges which you can keep in your backpack begin to have field-interchangeable benefits. Or will we see portable mapping GPS equipment with increased memory to give us 5 to 10 states of street-level mapping capabilities? Right now, portable street-level detail may only give you one or two cities, certainly not five or six states.

Marine cartography vector chart makers like C-Map and Navionics are still considering their options. What will the market demand when it comes to street-level cartography and boat harbor ports and services detail?

One of the most complete catalogs on low-cost marine electronics is available from Consumers Marine Electronics, located in Wahl, NJ. You may visit them on the web at www.cmelectron.com, or phone them for their all-color, 175-page, marine electronics catalog at 732-681-9025. This catalog has about the lowest prices mail order for marine equipment that can do double-duty in an RV or in your car.

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NOTEBOOK

by Robert Nansel

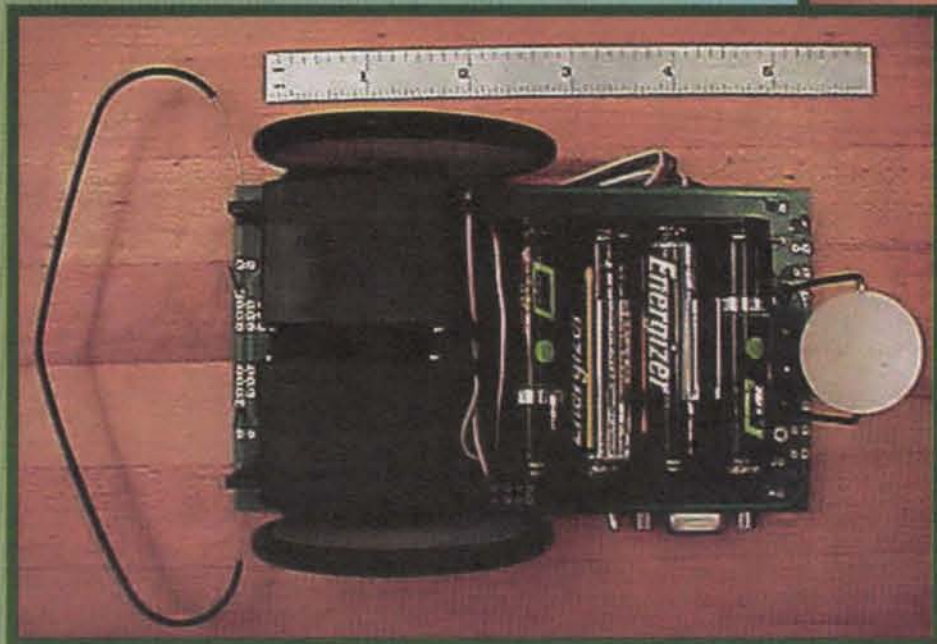
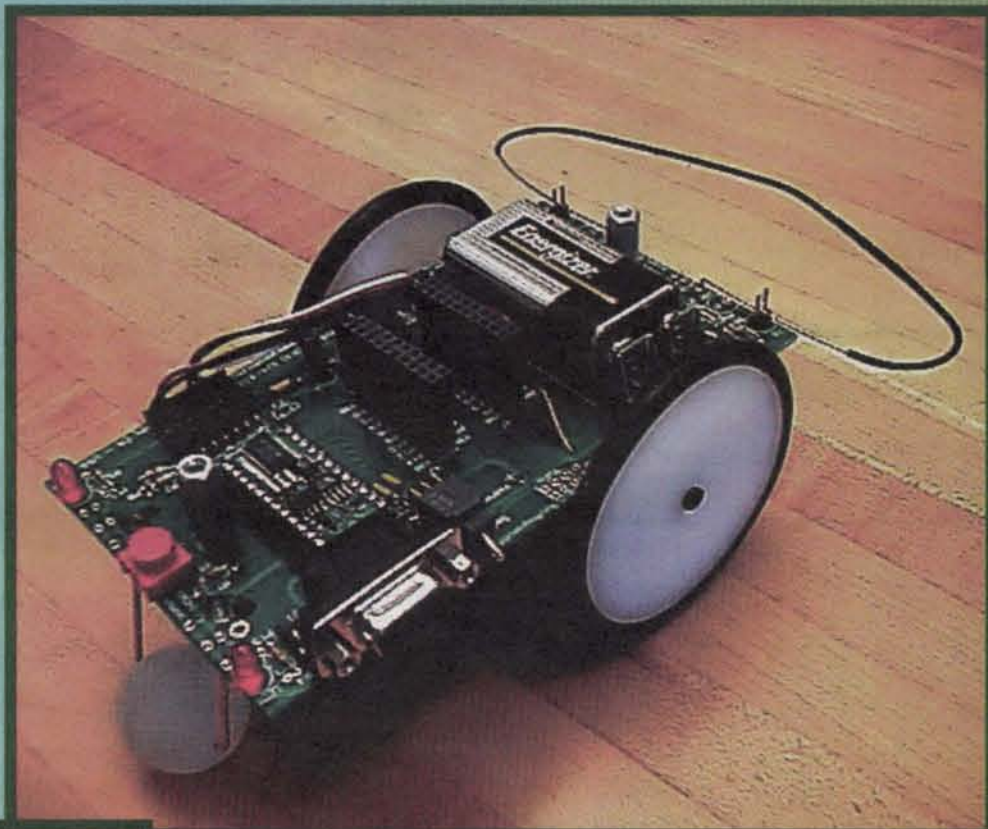
Last month, I was only able to give you a few glimpses of Parallax's new GrowBot kit. My first child had just been born — a healthy nine-pound boy! My in-laws and parents were in town to help out and to coo at my son Yonatan. And to take hundreds of pictures of him; at one point, there were so many flashes going off, it was like our household had been invaded by paparazzi. Things were sorta hectic around the robot ranch, see?

Nonetheless, I was able to put a GrowBot together on my kitchen table in between miscellaneous baby crises and photo-ops. However, I wasn't able to get downstairs to fire up Igor, the ancient 386 I keep locked up down in my basement. That meant I couldn't try out any of the software that comes with the GrowBot kit since, alas, Parallax doesn't have a version of their PBASIC development tool that runs on the Mac.

GrowBot through its paces. I also have some new web sites to recommend and a contest announcement later, but first I want to talk about GrowBot.

A Growing Bot

GrowBot is \$179.00 and for that you get an unassembled kit of parts (see photos) — everything you need to build a compact desktop-class robot. It uses standard hobby servos (included) for its drive-train. A 3" x 5.25" PCB serves as its chassis on which all other parts are mounted. Its wheels are 2-5/8" diameter, and its width overall (without the bow-tie bumper) is 3.75". With the bow-tie bumper,



(I know, I could run it with a DOS or Windows emulator on my Mac, but the idea of intentionally running DOS code on my Mac somehow seems evil and wrong.)

Anyway, some of last month's chaos has finally subsided. The grandparents have gone home; Yonatan is six weeks old and now weighs nearly 13 pounds (honest, milk is all we feed him, not steroids). While Yonatan doesn't sleep through the night yet, my wife and I have settled into something of a routine. I can get down to my workshop regularly enough to work on robots again, and I used my time this month to run

it's about 5.25" wide, and its overall length is 7.25". Its height without any AppModules installed is 2-5/8".

The GrowBot kit includes a prefabricated bow-tie bumper sensor. Unlike Breadbot, GrowBot doesn't have side whisker sensors; it makes do with just two input bits to distinguish left, right, and center.

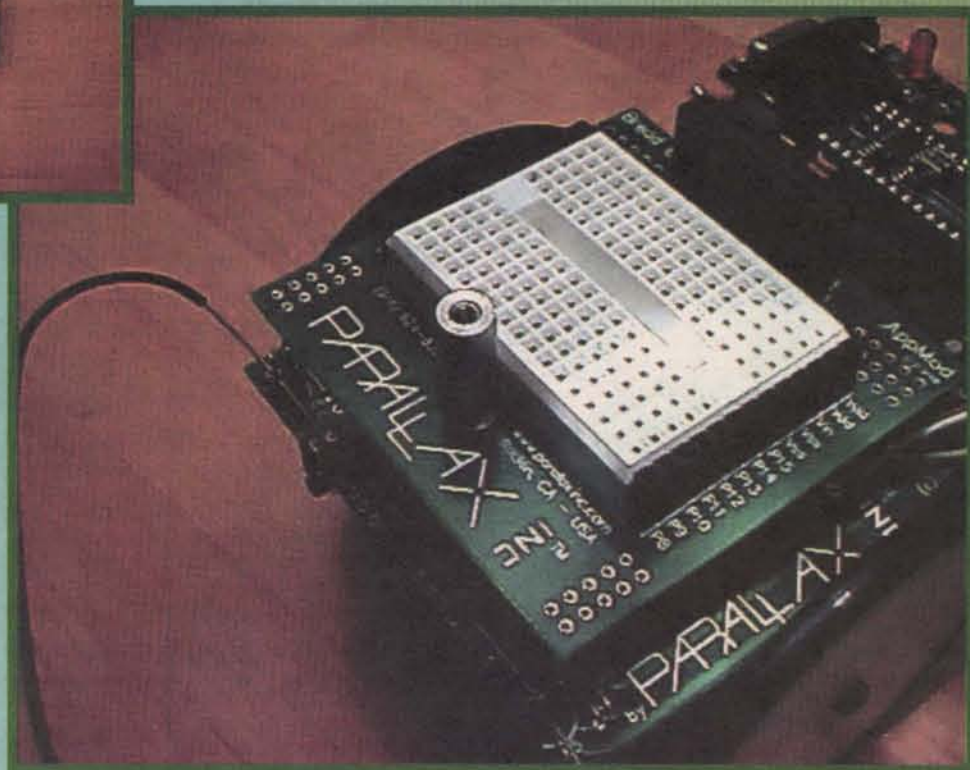
Other running hardware includes a user-programmable push-button switch, a small speaker, and two rear "tail light" LEDs. The speaker

circuit can also be used to monitor servo battery voltage, though the manual doesn't show how to use this function. I measured the impedance of the sounder with a DVM: It's about 50 ohms, a dead short to ground compared to the 220K ohm pullup and 100K pulldown resistors. Combined with the speaker's 10 uF coupling capacitor, I imagine it's intended to be used with

PBASIC's RCTIME command to digitize the level of Vservo, though the manual doesn't talk about this.

AppMods

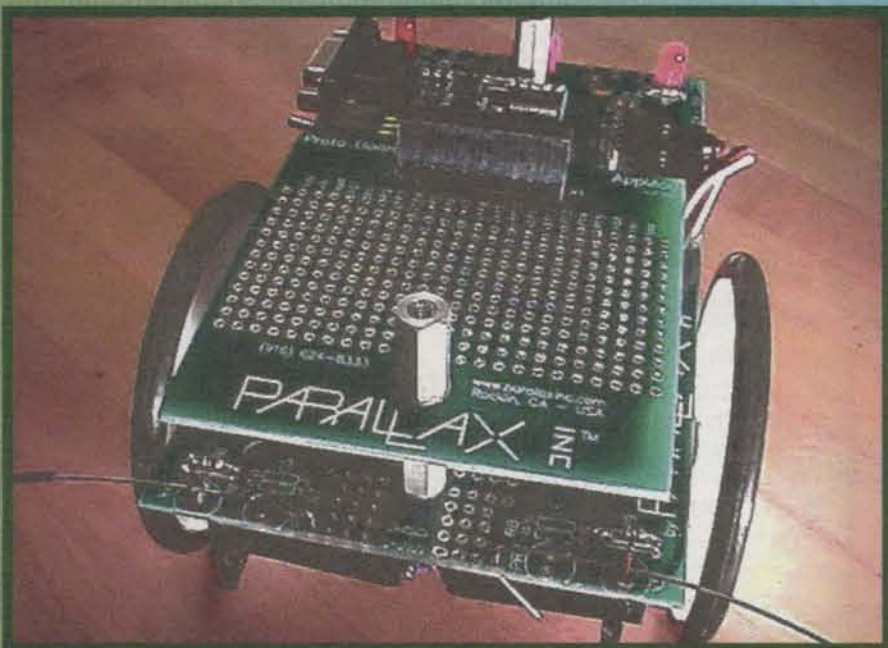
In the middle of the PC board are two 20-pin female header connectors that allow customization and expansion of GrowBot with what Parallax calls AppMods. These are 2.5-inch-square stacking daughterboards. One end of an AppMod





has the 20-pin stacking connector, and the other end has a hole for a 4-40 male/female aluminum hex standoff that ties the AppMod rigidly to the GrowBot chassis or to

brought out on GrowBot's AppMod connectors. There are currently two module types available: the solderless Breadboard (P/N 29114, \$29.00 US) and the lower



another AppMod below.
All 16 of the BS2-IC I/O lines, plus Gnd, Vss, and Vdd, are

profile Prototype Board (P/N 29110, \$19.00 US). The Prototype Board has a stacking clearance



height of 1/2", so you won't be able to use standard wirewrap construction, but point-to-point will work just fine. The Bread Board module has enough room for a couple 16-pin DIPs. It has a 5/8" stacking clearance, but all components you plug into the solderless breadboard have less than 1/4" clearance if you plan to stack another AppMod on top.

The Prototype Board has a 13-column by 24-row grid of pads but, for some reason, Parallax chose to bus together the second, third, and fourth columns on both the left and right edges of the board for Gnd, Vin, and Vdd. Not only that, they left the single columns of pads closest to the edges isolated from all the other pads. Most of the two rows of pads closest to the stacking connector are committed to the expansion bus, effectively reducing the uncommitted prototyping area to a grid of just 11 columns by 16 rows.

My preference would have been to lay out power and ground on either the left or the right side (but not both), and to start with that first column. This would have given an effective 11-column by 21-row grid — much more useful. You'd be able to prototype with a 40-pin DIP, for instance, or a couple 16-pin DIPs end-to-end.

Another style of prototype board would be a simple PC board version of the Bread Board AppMod so you could transfer circuits you breadboard directly to a more permanent (and cheaper) AppMod. If this sounds like I'm complaining, I'm not. I'm hoping Parallax will eventually come out with more AppMods that address these concerns.

Some upcoming AppModules include the "ISD Mobile Recording Studio" (P/N 29111) and the "LED Display Terminal" (P/N 29112). These should be available by the time you read this, though I don't know what the pricing will be.

The Civilized Robot

One nice feature of GrowBot is that it uses separate batteries to power the BS2-IC and the servos, thus increasing battery life and system reliability. The kit also includes a three-position power switch. When the switch is in the center position, this allows programming and debugging your software without servo power applied. No more runaway robots and no more yanking the servo connectors off every time you want to test code.

Another civilized feature is that the kit comes with a standard DB-9 serial connector for programming the BASIC Stamp. And a cable so you can connect directly to your PC. All in all, GrowBot is an elegant, well-thought-out kit.

Some Assembly Required

The only tools you need are a soldering iron, a small Phillips screwdriver, a small pair of diagonal cutters, and a pair of needle-nose pliers. A pair of scissors and a hobby knife come in handy, too.

The assembly manual gives a definite order of assembly which I highly recommend you follow since some components (the AA-cell battery holder and the velcro servo mounting pads) must be installed on the underside of the board only after all the components on the other side are soldered in. The only place I deviated from their suggested order was with the photoconductive cells.

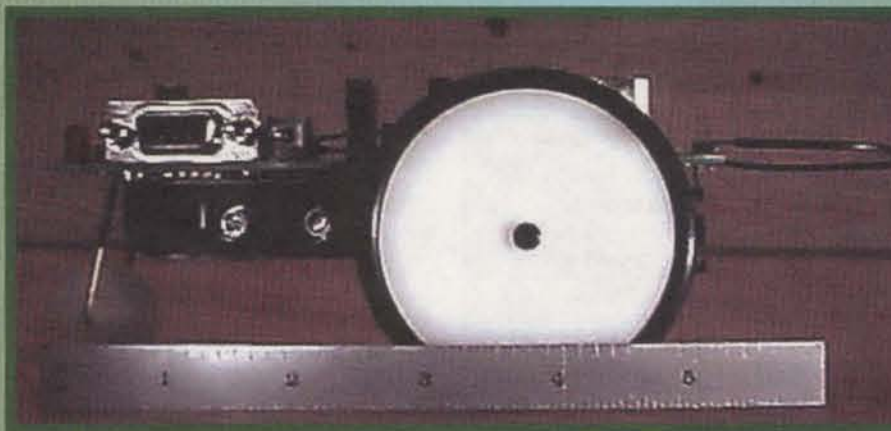
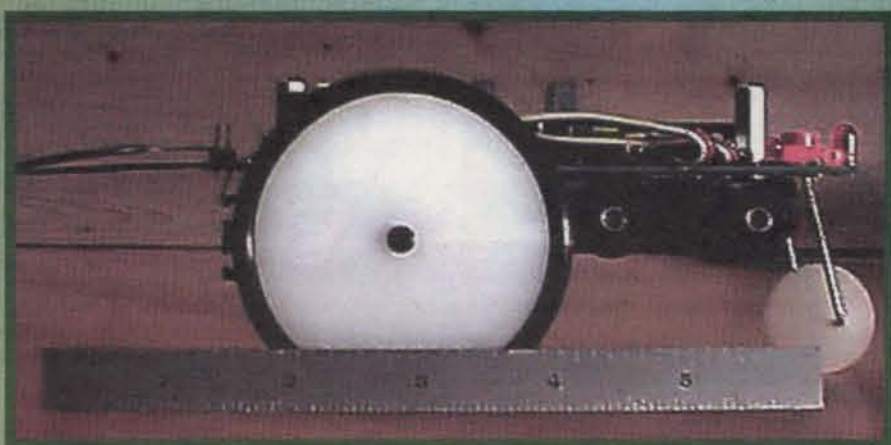
I was eager to get the basic system up and running, and since the photocell sensors aren't used by the ROVER.BS2 program, I left them out. They are no trouble to add later when you want to run EDGE.BS2 (which does make use of the photocells), and they are somewhat fragile and tend to get in the way. I have come up with a couple suggested changes to the way these sensors are mounted, but I'll get back to that in a moment.

Servo Mods

The only part of assembly that can be considered tricky is the modification of the servos included with the kit. These are stock Futaba FP-S148 servos, so they must, of course, be modified for continuous rotation. There are several ways to modify servos, but the way I've always done it is to open the servo, remove the position feedback potentiometer from the circuit board, and replace the pot with a fixed resistor divider network — very simple and rugged (see <http://www.seattlerobotics.org/guide/> for a good illustration of this method).

Parallax chose another method, one which I'd known about but had never tried before I built GrowBot: they keep the potentiometer in place, but mechanically disengage the potentiometer shaft from the servo output shaft. This is accomplished by removing a plastic coupler that links the potentiometer to the output shaft, an operation that is more easily reversed than the fixed resistor method. Since no desoldering is involved, the servos don't have to be disassembled as far (only the gear case cover needs to be removed).

Also, it's a snap to calibrate the stop ranges of the servos. While the gear case cover is off, you simply feed 1.5 msec pulses to each servo and then adjust the potentiometer until the motor stops turning. The nifty thing Parallax did was to pre-program the BS1-IC controller included with the kit to pro-



duce these 1.5 msec pulses on the servo ports.

The test software (GROWTEST.BS2) also facilitates testing the rest of GrowBot's hardware, the bumper sensors, the push-button switch, the speaker, and the rear "tail light" LEDs.

Roll Over, Rover

ROVER.BS2 was the program I was really eager to try. It is broadly similar in behavior to Breadbot's WANDER.ASM program from last month. One difference is that GrowBot doesn't pick a random direction to turn after it backs up from a head-on collision; it always turns the same direction, a backing left turn.

Another difference is that GrowBot uses its LED tail lights to show which bumper switch closed

(left, right, or both), and consequently what evasive maneuver it is performing. It also chirps on completing a turn after a head-on collision. Though I generally consider myself immune to such cosmetic details as blinky lights on robots, I must admit that they imbue GrowBot with a certain personality. It also makes it simple to tell what GrowBot is up to at any moment.

GrowBot's bow-tie bumper also performs very well; it is fully up to the task of determining whether a collision occurred on the left, right, or center, even though it lacks separate left and right whiskers. I suppose this means that if I rewired Breadbot's own bow-tie bumper to use two I/O bits instead of just one, and modified the software accordingly, I could get Breadbot to resolve five collision directions: left, front-left, front, front-right, and

right (that will have to be a project for a future column, though).

GrowBot on the Edge

The second major program included with the GrowBot kit is EDGE.BS2, which performs two functions: First, it uses the bumper to change direction when it runs into objects; second, it uses the photoresistors in front to avoid falling off the edge of the table (or crossing dark areas on a surface).

On my table, at least, EDGE isn't too successful. It runs GrowBot a little too fast, first of all, which tends to make the photo-sensing flaky, but that's just a matter of tweaking the code.

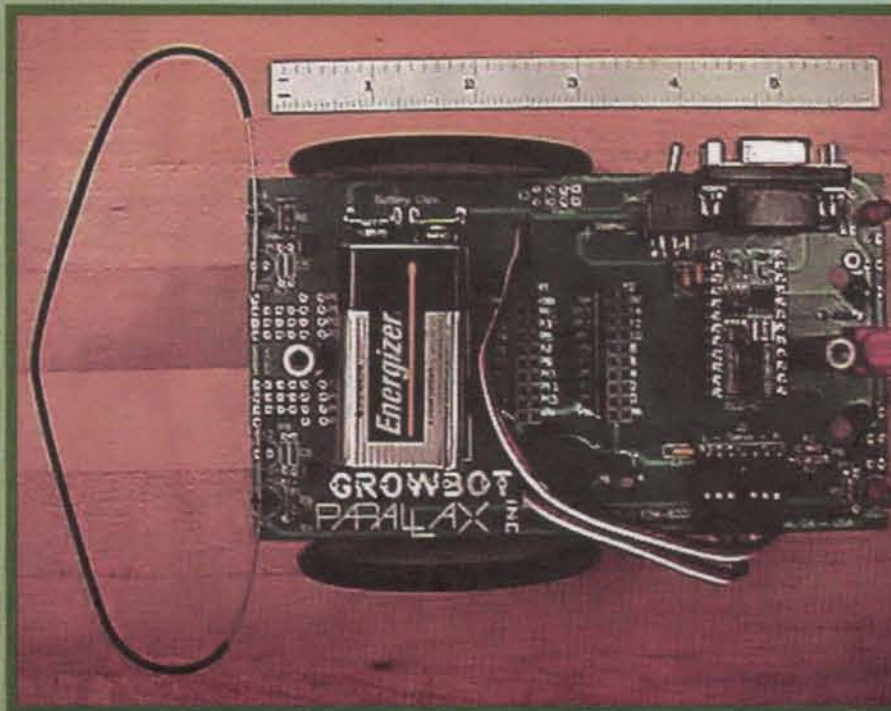
The more serious problem is that, even when the sensors work as planned, it's physically impossible for a robot with only two front-mounted sensors to avoid backing off the edge of the table at some point in its maneuvering.

Make no mistake; it's nice to be able to experiment with photocells as drop-off detectors; just don't bet your robot on that capability. I had to catch my GrowBot from tumbling off my kitchen table several times during my tests. There are several uncommitted pads along the rear edge of GrowBot's PC board, though, so rear-mounted drop-off detectors are a definite possibility and would make an excellent add-on project (yet another project for a future column).

If you start tweaking the code for EDGE, it will soon become apparent that it would be relatively straightforward to change the steering logic in the program to transform GrowBot into what's known as a *photovore* (a robot that steers toward light). By reversing the logic or the sensors in software, you'd get a *photophobe* (a robot that steers away from light).

You would probably want to bend the photoresistor leads so the sensors faced forward, and you might want to add some mechanical support and insulation so the leads won't short out against each other or the bow-tie bumper.

Hint: Plastic coffee stirrers work very well as mechanical supports and insulation. Visit a donut shop and get the kind that are like tiny, two-tubed drinking straws. Before soldering your photocells to the PC board, cut two lengths of coffee stirrer to about 1-1/4" each, about a quarter-inch shorter than the lead length of the photocells. Insert the leads of each photocell into the holes of its coffee stirrer. If you want the photocell to face forward, all you do is heat the middle of the stirrer for a few seconds with a heatgun or can-



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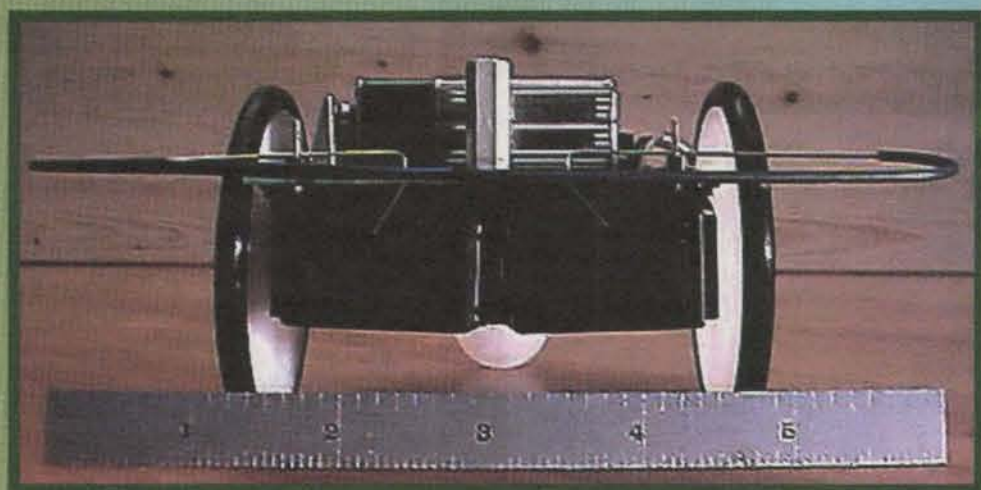
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dle flame until the plastic is soft enough to bend; make a quarter twist and then make a 90 degree forward bend. Set aside to cool. This is also a good time to eat the donuts you bought.

Another useful modification to make in conjunction with the above is to modularize the photocells by soldering two-pin male header connectors in the pads meant for the photosensors. Where the manual says to solder the photocells, solder in the headers instead so they stick

down from the underside of the board. Then solder the leads of each photosensor to its own two-pin female header. Now you can easily remove and replace the photoresistor sensors. Or, even entirely change the type of sensor.

What's Missing

I'd like to see more examples of robot programming techniques in the manual — not necessarily complete programs such as EDGE

and ROVER. But at least program fragments that show you how to accomplish various functions. One example that immediately comes to mind is how to program the battery monitor function.

I'd also like to see a few hardware project examples. There are a number of uncommitted pads on the PC board, so some simple project examples that you could do by wiring in a few components from

RadioShack would be ideal. Of course, any large-scale projects would more properly be done with AppMod boards. I don't know if Parallax intends to include suggested project booklets with the Bread Board or Prototype Board AppMods, but it would certainly be a good idea.

Perhaps Parallax could sponsor a project competition to encourage folks to design their own AppModule projects, then publish the projects they receive in a booklet. Everybody wins. Whatever they ultimately do, I do plan to present my own AppMod projects in this column from time to time in the future. And if any of you out there with GrowBots build projects of your own, I'd love to hear about them.

Breadbot Code Online

A couple weeks ago I got a note from Kevin Coble, the author of MacPIC, a superb Macintosh integrated development environment for PIC chips. Kevin has started a webpage devoted to those of us gearheads who prefer to use Macs as our main development machines, and it's called the MacRobotics webpage.

The best part is that Kevin has graciously offered to make Breadbot's PIC assembly source files available online from MacRobotics (<http://www.MacRobotics@MacRobotics.com>). For the most part, MacPIC is compatible with all of the MPASM and MPLAB directives, but he does have to make some slight modifications to the files so they will assemble correctly with MacPIC. All the changes he makes are clearly marked, though, and any DOS or Windows specific stuff is merely commented out, so the changes are easily reversed for those of you DOS or Windows users who don't want to retype the files. Thanks, Kevin.

DiaperBot

I wish. I daydream about such a machine, but my son will probably be in college by the time I get

DonTronics
P.O. Box 595
Tullamarine 3043
Australia
Tel: 613+9338-6286
Fax: 613+9338-2935
dontronics.com
(SIMMStick PC boards, development systems, & software)

MacPIC, by Kevin Coble
<ftp://ftp.srv.net/pub/users/kxc/>
(Macintosh shareware: integrated editor, assembler, simulator/debugger, & programmer for PIC microcontroller)

MacRobotics Webpage
www.MacRobotics@MacRobotics.com

Parallax, Inc.
3805 Atherton Road, Ste. # 102
Rocklin, CA 95765
Tel: 1-800-512-1024, 1-916-624-8333
www.parallaxinc.com
(GrowBot, SX-Key debugger/programmer, BASIC Stamps)

The SIMMStick Webpage
www.simmstick.com

something like this worked out. Oh, well.

In the meantime, I have plenty to keep me busy. Another note I received recently was a contest announcement from Don McKenzie of Dontronics fame. He and other SIMMStick Dealers around the world are sponsoring SIMMStick Design Contest99. Design your system using SIMMStick products (of course) and you could win up to \$500.00 US. Many other prizes such as SIMMStick boards, regional prizes, etc.

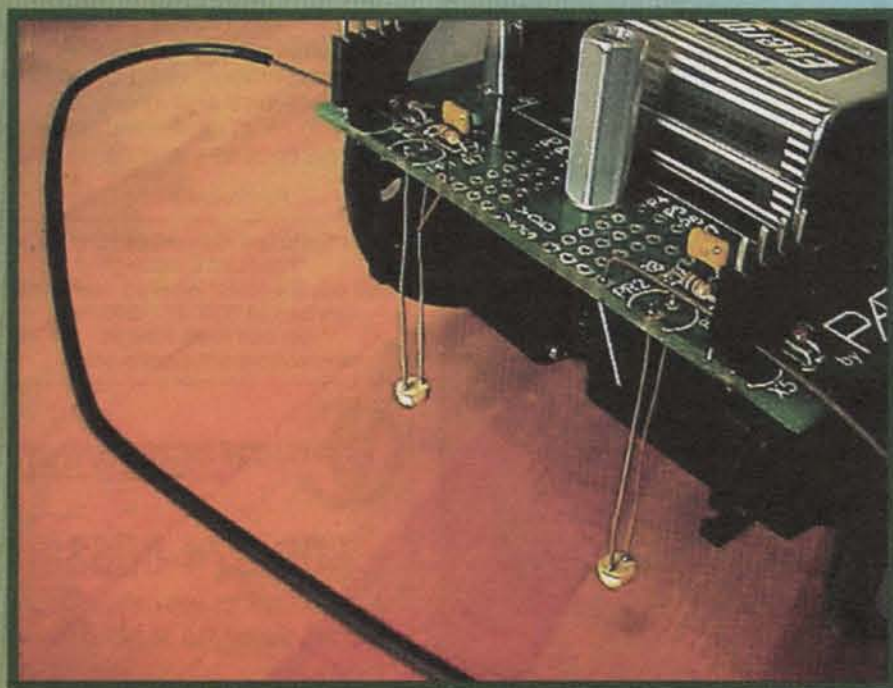
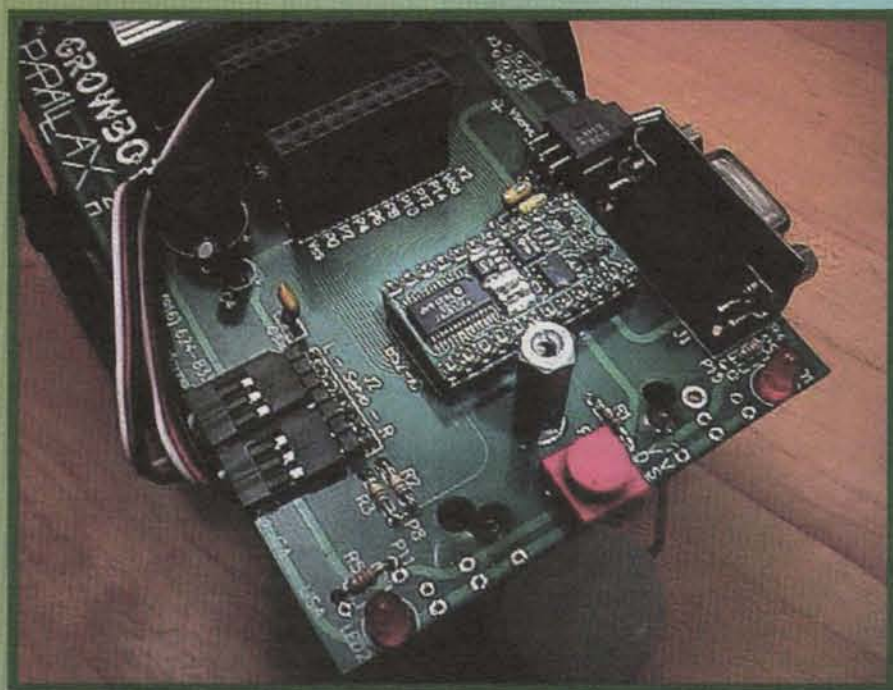
SIMMStick products currently support PICmicro and Atmel Micro controllers (8051/AVR). However, you may use any microcontroller or peripheral you like, provided it is mounted on a SIMMStick board. The deadline for contest entry is November 1, 1999. For more information, check out <http://www.simmstick.com>.

That's it for this month. Next time, we'll talk about wheel speed sensing and odometry techniques.

NV

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

Robert Nansel
69 S. Fremont Ave. #2
Pittsburgh, PA 15202
E-Mail: bnansel@nauticom.net



New Product News



QUAD COMPRESSOR

American Innovations, Inc. introduces the CQ-204 Color Quad Compressor. This color quad compressor will enable you to view and/or record up to four cameras in real time on one monitor or VCR.

The compressor has four BNC video inputs, one alarm input remote control that supports up to four sensors, and two video outputs.

The compressor works in real time 60 fields/sec for NTSC and 50 fields/sec for PAL. The compressor features high resolution – (1024 x 512 pixels), quad and full screen selection, freezes individual quadrant function,

manual and automatic switching with programmable dwell time, and video loss detection with on-screen warnings.

The CQ-204 Color Quad Compressor measures 14 x 10 x 2 inches, and weighs 5 pounds.

The special introductory price is only \$325.00.

For more information, contact:

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The radio is secured in the upper compartment in an adjustable radio sling that allows the unit to be raised or lowered easily for access. A lower compartment is designed to hold a rechargeable battery power supply.

The price of the World Pack is \$57.95, P/N HMP. The cost of the power supply kit is \$63.95, P/N HPP9A.

For more information, contact:

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Other features include an HF-communication grade crystal, IF bandpass filter, built-in heavy duty speaker, full analog mechanical S-meter, optional semi-break-in CW module, and easy-to-operate controls.

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encourages high energy efficiency. The MFJ-9410X costs \$259.95 and comes with a rugged 3-1/2" top mount speaker.

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601-323-5869 FAX: 601-323-6551

MICROPAC HC16 SBC WITH 1 MEG OF FLASH MEMORY

EMAC, Inc., announces that the MicroPac HC16 SBC now has 1 Meg of flash memory. The MicroPac HC16 can also have up to 1 Meg of RAM.

The processor utilizes the Motorola 68HC1621 16-bit microprocessor which is code-compatible with 68HC11 controllers.

This high-integration processor features integer DSP capability, programmable I/O ports, interrupt controller, watchdog timer, A/D converter, pulse width modulation (PWM) capability, and timer/counters.

EMAC integrated this powerful processor onto a board that contains 24 digital I/O lines, two serial RS232/485 ports, battery backed real-time clock/calendar, LCD interface, keypad interface, eight channels of A/D, and eight channels of D/A.

The MicroPac HC16 comes equipped with a Background Debug Mode (BDM) port. Through this port, programs can be downloaded and debugged. The BDM when used with the battery backed RAM and development software provides a full featured development system with features comparable to those of an In-Circuit Emulator.

DSP capability, fast analog conversions, and low interrupt latency time make

this board ideal for demanding real-time applications.

The cost of the MicroPac HC16 is \$249.95 US dollars in quantity of one.

WINDOWS CE CERTIFIED SBC-456/E

EMAC, Inc., announces that the SBC-456/E – a 486 PC compatible Single Board Computer – is now certified for Windows CE. This allows customers to utilize their knowledge of Windows API so they can develop embedded applications with minimal size and complexity.

The SBC-456 (non-Ethernet) and SBC-456E (with Ethernet) are half-sized AMD DX5-133 CPU cards with VGA/LCD interface. These boards offer an ISA bus and a PC/104 bus, DiskOnChip, and two COM ports.

The cost of the SBC-456 is \$387.00 and the SBC-456E is \$411.00 (US dollars) in quantity of one, including the CPU, but without memory.

For more information, contact:

EMAC, INC.
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Other Models are Available. See www.web-tronics.com under "hard drive and accessories" for more details and pictures.

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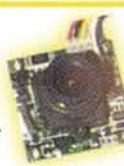
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VM1036A
Standard lens with audio, 32mmx32mmx25mm, 12V, 430 horz & vert TV lines, reverse mirror image feature
\$69.00 \$63.00
5 or more

COLOR CCD Mini Board Cameras

• Low Power Consumption
• 1 Lux Illumination
• Built-In Electronic Auto Iris for Auto Light Compensation
• Internal Synchronization
• 12Volts
• 400 TV Lines



VM3011-A
Standard lens with audio, 45mmx40mmx24mm, single board
\$147.00 \$139.00
5 or more



VM3010PA
Pinhole lens with audio, 33mmx33mmx18mm
\$149.00 \$137.00
5 or more



VM3010-A
Standard lens with audio, 33mmx33mmx32mm
\$144.00 \$129.00
5 or more

Detailed Specs on the Web

Bullet CCD Cameras

• B&W and Color
• Smart Rugged Metal Housing
• Extremely Low Power Consumption
• 12 Volt
• CCD Area Image Sensor for Long Camera Life
• Built-In Electronic Auto Iris for Auto Light Compensation
• No Blooming, No Burning
• 0.1 Min Lux Illumination (B&W), 1 Lux Min Lux Illumination (color)



VMBLT3025W
Digital Color, Weatherproof, 20mm(D)x83mm(L)
\$219.00 \$199.00
5 or more

VMBLT1020W
B&W Weatherproof, 21mm(D)x58.5mm(L)
\$96.00 \$89.00
5 or more



VMBLT1020A
B&W with audio, 21mm(D)x55mm(L)
\$85.95 \$77.00
5 or more

Detailed Specs on the Web

Protek Amazing Test Equipment Offers

Series 6500 Deluxe
20MHz/40MHz/60MHz/100MHz
Dual-Trace Oscilloscopes

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• Internal Sync Separator Circuit
• Alt-Mag Sweep
• Delay Sweep (6510)

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#6504 - 40MHz \$569

#6510 - 100MHz \$799

#6506 - 60MHz \$689

Part No.	Bandwidth	6510	6506	6504	6502
Bandwidth	100MHz	100MHz	60MHz	40MHz	20MHz
Vert. Sensitivity	1mV/DIV to 5V/DIV	1mV/DIV to 5V/DIV	1mV/DIV to 5V/DIV	1mV/DIV to 5V/DIV	1mV/DIV to 5V/DIV
Max Sweep Rate	2nS/DIV to 0.2S/DIV	2nS/DIV to 0.2S/DIV	0.1uS/DIV to 0.2S/DIV	0.1uS/DIV to 0.2S/DIV	0.2uS/DIV to 0.5S/DIV
Delay Sweep	YES	YES	YES	YES	YES
Vert. Mode Trig.	YES	YES	YES	YES	YES
Cursor Readout	NO	NO	NO	NO	NO
CRT Volts	12KV	10KV	10KV	10KV	2KV

For More Information See www.web-tronics.com**Amazing Test Equipment Offers**

10MHz Pulse Generator

• Max. 10MHz Rate
• Adjustable Delay Time & Pulse Width
• External Oscillator Input
• Variable Output Level Control
• Delay Function
• Frequency Counter

B1010
\$269 See the web site for details



2GHz Universal Counter

• Frequency, Period, Totalize Ratio Measurements
• Low Pass Filter
• 3 Channel Input (CH A, CH B, CH C)
• Variable Trigger Level
• 8 Digit LED Display
• 4 Step Gate Time Control
• FI/IO Input Attenuator
• Self Test

U2000A
\$319 See the web site for details



1GHz Multifunction Counter

• Frequency, Period, Totalize Measurements
• Low Pass Filter
• 2 Channel Input (100MHz, 1GHz)
• 8 Digit Gate Time Control
• 1/20 Input Attenuator

B-818
\$209 See the web site for details



Digital Multimeter

• AC/DC Voltage, AC/DC Current, Resistance Measurement
• 4 1/2 Digit Display
• Over Range Indication
• 7 Functions
• Data Hold Function

9902A
\$189 See the web site for details



10MHz Sweep Function Generator

• Sine, Triangle, Square, Ramp, Pulse Waveform
• Gate & Trigger Output
• Burst Waveform Output
• Sweep Function (Linear/Logarithmic)
• VCG Input
• GCV Function
• AM Modulation
• Variable Symmetry
• Output Attenuator
• DC Offset
• Frequency Counter

B-810
\$559 See the web site for details



2MHz Sweep Function Generator

• Sweep Function Width: 1:1 to 1000:1
• Sweep Rate: 0.5Hz to 50Hz
• Attenuation: -20dB
• Frequency Range: 0.02Hz to 2MHz in 7 Ranges
• Outputs: Sine, Triangle, Square Wave, Pulse, Ramp, Slew Sine Wave
• Sync Out: TTL Square Wave

9205
\$219 See the web site for details



20 Amp Switching Power Supply With Overvoltage Protection and Variable DC Output

Specifications
Input Voltage: AC 110V ±15%, 50Hz/60Hz
Output Voltage: DC 9V - 15V variable
Polarity: Negative ground
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Overvoltage Protection
Cooling fan inside chassis

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See the web site for details #SPS-1020G



2MHz Sweep Function Generator

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• Sync. Output (TTL Square Waveform)
• Sweep Function
• VCG Input
• DC Offset
• Variable Symmetry

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#3201
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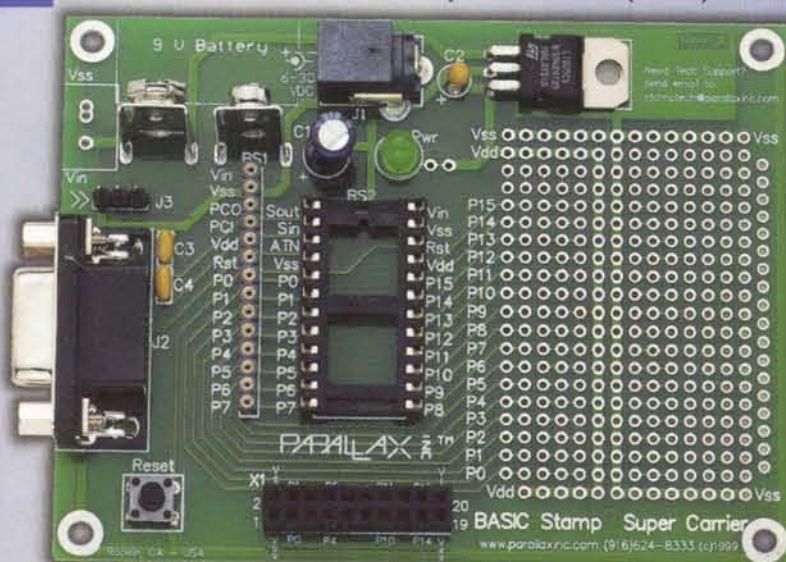


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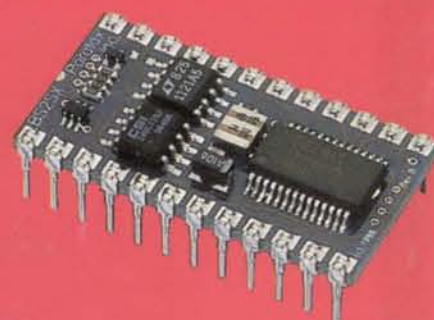
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The kit includes a BS2SX-IC module, the Super Carrier Board, BS2SX Win95/98/NT Interface, BASIC Stamp manual version 1.9, software and a serial cable. The BS2SX Starter Kit will be available April 15, 1999, for the introductory price of \$159.

The **Super Carrier Board (#27130)** is available separately for the introductory price of \$39.

To order call Parallax at (916) 624.8333
sales hours: Mon-Fri 8am-12pm and
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